NEW MAIL-EXAMINATIO

Barlow

THE RADIO AMA

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MANU

- F.C.C. REGULATIONS
- A STUDY GUIDE FOR THE AMATEUR EXAMS
- RENEWING AND MODIFYING STATION LICENSES
- HOW TO GET YOUR AMATEUR RADIO LICENSES

50¢

A R R L

PUBLISHED BY THE AMERICAN RADIO RELAY LEAGUE

NOTE: This edition is based on new regulations effective June 10, 1954—principally the availability of Novice and Technician amateur license examinations by mail procedures only. Prior to that date, applicants for amateur license living within 125 miles of a quarterly examining point must appear for personal examination.

The Radio Amateur's
LICENSE MANUAL

$$f_{mc} = \frac{300}{m}$$

$$m = \frac{300}{f_{mc}}$$

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CHAPTER 1

Amateur Licensing

The operation of an amateur radio transmitting station is a privilege made available by the Government, through an agency called the Federal Communications Commission, to any citizen of the United States who can qualify. The granting of this privilege in the form of federal licenses is subject to the applicant's ability to demonstrate basic radio technical and code knowledge, and familiarity with regulations governing the amateur service. A primary purpose of licensing is to ensure that the operator of a radio transmitter is sufficiently skilled that he will not, by improper adjustment of his equipment or lack of knowledge of regulations, cause interference to other services using the radio spectrum.

To own and operate an amateur radio station in the United States or possessions it is necessary to have two licenses, both of which are issued by the Federal Communications Commission from its main office in Washington, D. C. For the operator himself there is the *operator license*, issued after the individual has passed a code test and a written examination designed to test his familiarity with radio law and regulations and his knowledge of the proper operation of amateur radio transmitting equipment. This examination may be taken at any of numerous field offices of the Commission, or in certain cases by mail, as will be explained later. For the transmitting equipment itself there is the *station license*, which authorizes the operation of transmitting equipment at a specified location and also authorizes portable and mobile operation as permitted under the regulations. Actually, the license itself is a single card form containing both the operator and station authorization on its face, and terms and conditions on the reverse side. It is not necessary that you post your license in your radio room, but it is required that you have it in your personal possession whenever and wherever you are operating.

It is absolutely essential that both licenses be obtained before an amateur station of any kind is operated. We wish to emphasize this point and, further, to emphasize that there are no exceptions to the requirement for licenses for any of the kinds of work an amateur is interested in undertaking. Those who, after study, think that the language of the law is such as to permit of some special interpretation which will enable unlicensed operation under certain conditions are warned that the language of the law is air-tight, and no such special interpretations are possible. Please do not write us, therefore, asking if unlicensed operation isn't all right if the power used is so low that the station won't be heard over the state line, or if licenses are required for 2-meter transceivers, or anything of that sort; you will only be wasting your time and ours. There are no special cases; government licenses are *always* necessary. The loss of future operating privileges as well as the prospect of fine and imprisonment face the unlicensed operator who is sure *he* is an exception.

There is no age limit for amateurs. However, only American citizens can obtain licenses to operate amateur stations in the United States (except for a special arrangement with Canada, described later). Since aliens possessing first papers are not yet full-fledged citizens, they also are barred from holding licenses.

License Structure

The present license structure provides a variety of amateur license classes. The chart on the following page lists each class and its requirements and privileges. To determine that the applicant has ability necessary to enable him to operate an amateur station properly with the various privileges his license grants, the Government requires that he pass a written examination (in addition to filling out an application form) to show that he is familiar with radio theory, operation and adjustment of basic transmitting equipment, both telegraph and 'phone, and with the essential parts of the radio law and regulations. The scope of the examination varies with the type of license, being extremely simple for the Novice Class and graduating to a rather difficult examination for the Amateur Extra Class. The written examination for each class is described later in this booklet under the appropriate chapter. It is also required that the applicant demonstrate ability to send and receive International Morse "Continental" code at a rate of speed commensurate with the license class — 5 words per minute for Novice and Technician, 13 w.p.m. for General and Conditional Classes, and 20 w.p.m. for Amateur Extra Class. Perfect copy and sending must be accomplished for one minute out of a five-minute test. That the applicant intends to use 'phone rather than telegraphy does not excuse him from the code test; everybody has to take it. It is a basic requirement of international treaty.

Learning the code is mostly a matter of practice. Instructions on learning it, on how to handle a key, data on practice sets, etc., are contained in a companion booklet entitled *Learning the Radio-Telegraph Code*, obtainable for 25¢, postpaid, from the American Radio Relay League, West Hartford 7, Conn.

AMATEUR OPERATOR LICENSES

Class	*Prior Experience*	*Code Test*	*Written Examination*	*Privileges*	*Term*
Novice (By mail only)	None	5 w.p.m.	Elementary theory and regulations	Telegraphy in 3700–3750, 7175–7200, and 21,100–21,250 kc., and telegraphy or voice in 145–147 Mc. Crystal control required; 75 watts maximum input.	One year, not renewable
Technician (By mail only)	None	5 w.p.m.	General theory and regulations	All amateur privileges above 220 Mc.	Five years, renewable
General	None	13 w.p.m.	General theory and regulations	All amateur privileges	Five years, renewable
Conditional [1]					
Advanced [2]				All amateur privileges	Five years, renewable
Amateur Extra	Two years since 1934,[3] except as Novice or Technician	20 w.p.m.[3]	General theory and regulations, plus special exam[3] on advanced techniques	All amateur privileges	Five years, renewable

[1] Same as General Class, except examination taken by mail.

[2] Not available to new applicants.

[3] Waived for persons who hold or can qualify for a General or Advanced Class license and who can show that they held amateur license prior to May, 1917.

FCC Field Organization

The Federal Communications Commission maintains an extensive Field Engineering & Monitoring Bureau, which among many other duties conducts examinations for radio operator licenses. There are 24 district administrative offices, as follows:

Boston, Mass.
New York, N. Y.
Philadelphia, Pa.
Baltimore, Md.
Norfolk, Va.
Atlanta, Ga.
Miami, Fla.
New Orleans, La.
Houston, Tex.
Dallas, Tex.
Los Angeles, Calif.
San Francisco, Calif.
Portland, Ore.
Seattle, Wash.
Denver, Colo.
St. Paul, Minn.
Kansas City, Mo.
Chicago, Ill.
Detroit, Mich.
Buffalo, N. Y.
Honolulu, T. H.
San Juan, P. R.
Juneau, Alaska
Washington, D. C.

Examinations are given frequently at these offices, as well as at the suboffices at Anchorage, Alaska (branch of Juneau), Savannah (branch of Atlanta), Tampa (branch of Miami), San Diego (branch of Los Angeles), Mobile (branch of New Orleans), and Beaumont, Tex. (branch of Houston). In addition, examinations are held four times each year in the following cities:

Birmingham, Ala.
Charleston, W. Va.
Cincinnati, Ohio
Cleveland, Ohio
Columbus, Ohio
Corpus Christi, Texas
Davenport, Iowa
Des Moines, Iowa
Fort Wayne, Ind.
Fresno, Calif.
Grand Rapids, Mich.
Indianapolis, Ind.
Jackson, Miss.
Knoxville, Tenn.
Little Rock, Ark.
Memphis, Tenn.
Milwaukee, Wis.
Nashville, Tenn.
Oklahoma City, Okla.
Omaha, Nebr.
Phoenix, Ariz.
Pittsburgh, Pa.
St. Louis, Mo.
Salt Lake City. Utah
San Antonio, Tex.
Schenectady, N. Y.
Sioux Falls, So. Dak.
Syracuse, N. Y.
Tulsa, Okla.
Williamsport, Pa.
Winston-Salem, N. C.

This makes a total of 61 cities in which examinations for amateur radio operator licenses are available at least as often as four times per year.

Application Procedure

The procedure to be followed in applying for an amateur license depends upon the class involved. Novice and Technician Class examinations are given by mail only; see the appropriate chapters of this booklet for details. As for General Class licenses, an applicant who lives within 75 miles airline of the nearest of the FCC points listed in the left-hand column of this page must appear in person to take his examination. He can, however, appear at any one of these cities (or those listed on the following pages), not necessarily the nearest. An applicant for "general" privileges who lives more than 75 miles airline from any of the cities listed in the left-hand column, as well as the physically handicapped and also anyone in military service, is permitted to take the "general" examination by mail, in which case it is known as Conditional Class; see Chapter 5 for details. Examinations for Extra Class licenses are given by personal appearance only, at one of the above cities or those listed in the following pages.

FCC Form 610 is the standard application blank for amateur station and operator licenses, and may be secured by writing the FCC Engineer-in-Charge of the district in which you live (see the list of addresses on the next page). The amateur application is rather detailed but is straight-forward. The back of the form is concerned with special cases, such as an application for a club station, or an application taken by mail, described more thoroughly in Chapter 5, so in the situations covered by this section you need be concerned only with the face of the form. You should not be concerned over the item requiring you to waive claim to the use of any particular frequency or of the ether as against the regulatory power of the United States. This is a form requirement under the law, and agreement is required of all licensees, amateur or commercial. Question 16 of the form requires the signature of the official in charge of premises if your station is to be on premises under governmental, corporate or institutional control. This is to show that the necessary power to control the station location has been given you. Whenever the station is in your own home, owned or rented, the question has no applicability. For instance, you don't have to get a signature if your residence is in a Government housing project; you already control your own home, so in that case just skip the question. When the form has been filled out, have it notarized. (Notarization is not required for operator license only, but we assume you will be seeking both operator and station privileges.)

As personal appearance is required for a General or Extra Class license, of course you will appear at the specified time and place to take your examination; bring along your completed application form. First, the Engineer gives you your code test. You will probably be taking it along with other applicants. Then the Engineer will inspect your "copy" quickly and determine whether you have passed. It is required that you copy perfectly for at least one continuous minute

UNITED STATES RADIO DISTRICTS

Address the District FCC Engineer-in-Charge

District No. 1, 1600 Customhouse, Boston 9, Mass. The states of CONNECTICUT, MAINE, MASSACHUSETTS, NEW HAMPSHIRE, RHODE ISLAND and VERMONT.

District No. 2, 748 Federal Bldg., 641 Washington St., New York 14, N. Y. In the state of NEW YORK, the counties of Albany, Bronx, Columbia, Delaware, Dutchess, Greene, Kings, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Schenectady, Suffolk, Sullivan, Ulster and Westchester; in the state of NEW JERSEY, the counties of Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union and Warren.

District No. 3, 1005 Customhouse, Second and Chestnut Sts., Philadelphia 6, Pa. In the state of PENNSYLVANIA, the counties of Adams, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Perry, Philadelphia, Schuylkill and York; in the state of NEW JERSEY, the counties of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Ocean and Salem; and the county of Newcastle in the state of DELAWARE.

District No. 4, 508 Old Town Bank Bldg., Baltimore 2, Md. The state of MARYLAND; the DISTRICT OF COLUMBIA; in the state of VIRGINIA, the counties of Arlington, Clark, Fairfax, Fauquier, Frederick, Loudoun, Page, Prince William, Rappahannock, Shenandoah and Warren; the counties of Kent and Sussex in the state of DELAWARE; in the state of WEST VIRGINIA, the counties of Barbour, Berkeley, Grant, Hampshire, Hardy, Harrison, Jefferson, Lewis, Marion, Mineral, Monongalia, Morgan, Pendleton, Preston, Randolph, Taylor, Tucker and Upshur.

District No. 5, 402 Federal Bldg., Norfolk, Va. The state of VIRGINIA except that part lying in District 4, and the state of NORTH CAROLINA except that part lying in District 6.

District No. 6, 411 Federal Annex, Atlanta 3, Ga. The states of GEORGIA, SOUTH CAROLINA and TENNESSEE; the state of ALABAMA except that part lying in District 8; in the state of NORTH CAROLINA, the counties of Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Cleveland, Graham, Haywood, Henderson, Jackson, McDowell, Macon, Madison, Mitchell, Polk, Rutherford, Swain, Transylvania, Watauga and Yancey.

District No. 7, 312 Federal Bldg., Miami 1, Fla. The state of FLORIDA except that part lying in District 8.

District No. 8, 400 Audubon Bldg., New Orleans 16 La. The states of ARKANSAS, LOUISIANA and MISSISSIPPI; in the state of TEXAS, the city of Texarkana; in the state of FLORIDA, the county of Escambia; in the state of ALABAMA, the counties of Mobile and Baldwin.

District No. 9, 324 U. S. Appraisers Stores Bldg., 7300 Wingate St. Houston 11, Tex. In the state of TEXAS, the counties of Angelina, Aransas, Atascosa, Austin, Bandera, Bastrop, Bee, Brooks, Bexar, Blanco, Brazoria, Brazos, Burleson, Caldwell, Calhoun, Cameron, Chambers, Colorado, Comal, DeWitt, Duval, Dimmit, Edwards, Fayette, Fort Bend, Frio, Galveston, Gillespie, Goliad, Gonzales, Grimes, Guadalupe, Hardon, Hays, Harris, Hidalgo, Jackson, Jasper, Jefferson, Jim Hogg, Jim Wells, Karnes, Kenedy, Kendall, Kerr, Kinney, Kleberg, LaSalle, Lavaca, Lee, Liberty, Live Oak, Matagorda, Madison, Maverick, McMullen, Medina, Montgomery, Nacogdoches, Newton, Nueces, Orange, Polk, Real, Refugio, San Augustine, San Jacinto, San Patricio, Sabine, Starr, Travis, Trinity, Tyler, Uvalde, Val Verde, Victoria, Walker, Waller, Washington, Webb, Wharton, Willacy, Williamson, Wilson, Zapata and Zavala.

District No. 10, 500 U. S. Terminal Annex Bldg., Dallas, Tex. The state of TEXAS except that part lying in District 9 and in the city of Texarkana; the state of OKLAHOMA.

District No. 11, 539 Federal Bldg., Los Angeles 12, Calif. The state of ARIZONA; in the state of NEVADA, the county of Clarke; in the state of CALIFORNIA, the counties of Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara and Ventura.

District No. 12, 323-A Customhouse, San Francisco 26, Calif. The state of CALIFORNIA except that part lying in District 11; the state of NEVADA except the county of Clarke.

District No. 13, 307 Fitzpatrick Bldg., Portland 5, Ore. The state of OREGON; the state of IDAHO except that part lying in District 14; in the state of WASHINGTON, the counties of Wahkiakum, Cowlitz, Clark, Skamania and Klickitat.

District No. 14, 808 Federal Office Building, Seattle 4, Wash. The state of MONTANA; the state of WASHINGTON except that part lying in District 13; in the state of IDAHO, the counties of Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce and Shoshone.

District No. 15, 521 New Customhouse, Denver 2, Colo. The states of COLORADO, NEW MEXICO, UTAH and WYOMING; in the state of NEBRASKA, the counties of Banner, Box Butte, Cheyenne, Dawes, Deuel, Garden, Kimball, Morrill, Scottsbluff, Sherida and Sioux; in the state of SOUTH DAKOTA, the counties of Butte, Custer, Fall River, Lawrence, Meade, Pennington, Shannon and Washington.

District No. 16, 208 Federal Court Bldg., St. Paul 2, Minn. The states of MINNESOTA and NORTH DAKOTA; the state of SOUTH DAKOTA except that part lying in District 15; the state of WISCONSIN except that part lying in District 18; in the state of MICHIGAN, the counties of Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon and Schoolcraft.

District No. 17, 3200 Federal office Bldg., Kansas City 6E, Mo. The states of KANSAS and MISSOURI; the state of IOWA except that part lying in District 18; the state of NEBRASKA except that part lying in District 15.

District No. 18, 826 U. S. Courthouse Bldg., Chicago 4, Ill. The states of ILLINOIS and INDIANA; in the state of IOWA, the counties of Allamakee, Buchanan, Cedar, Clayton, Clinton, Delaware, Des Moines, Dubuque, Fayette, Henry, Jackson, Johnson, Jones, Lee, Linn, Louisa, Muscatine, Scott, Washington and Winneshiek; in the state of WISCONSIN, the counties of Brown, Columbia, Calumet, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Iowa, Jefferson, Keewanee, Kenosha, Lafayette, Manitowoc, Marinette, Milwaukee, Ozaukee, Oconto, Outgamie, Racine, Richland, Rock, Sauk, Sheboygan, Walworth, Washington, Waukesha and Winnebago; the state of KENTUCKY except that part lying in District 19.

District No. 19, 1029 New Federal Bldg., Detroit 26, Mich. The state of OHIO; the state of MICHIGAN except that part lying in District 16; the state of WEST VIRGINIA except that part lying in District 4; in the state of KENTUCKY, the counties of Bath, Bell, Boone, Bourbon, Boyd, Bracken, Breathitt, Campbell, Carter, Clark, Clay, Elliott, Estill, Fayette, Fleming, Floyd, Franklin, Gallatin, Garrard, Grant, Greenup, Kenton, Harlan, Harrison, Jackson, Jessamine, Johnson, Knott, Knox, Laurel, Lawrence, Lee, Leslie, Letcher, Lewis, Lincoln, Madison, Magoffin, Martin, Mason, McCreary, Menifee, Montgomery, Morgan, Nicholas, Owen, Owsley, Pendleton, Perry, Pike, Powell, Pulaski, Robertson, Rockcastle, Rowan, Scott, Wayne, Whitely, Wolfe and Woodford.

District No. 20, 328 Post Office Bldg., Buffalo 3, N. Y. The state of NEW YORK except that part lying in District 2; the state of PENNSYLVANIA except that part lying in District 3.

District No. 21, 502 Federal Bldg., Honolulu, T. H. The Territory of HAWAII and outlying Pacific possessions except Alaska and adjacent islands.

District No. 22, 323 Federal Bldg., San Juan, P. R. PUERTO RICO and the VIRGIN ISLANDS.

District No. 23, 6 Shattuck Bldg., Juneau, Alaska. The territory of ALASKA and adjacent islands.

District No. 24, Briggs Bldg., 22nd & E Sts., N.W. Washington, D. C. The boundaries of the District of Columbia extended ten miles.

out of the five minutes or so of code which will be sent as the test. Then the Engineer will examine you in sending ability. If you are successful in passing both the sending and receiving code tests at the required speed, the Engineer will give you the written examination for the appropriate license. This will probably take you an hour or more, but you can spend any reasonable amount of time in preparing your paper. After the examination is completed, hand it to the supervising Engineer. Often his staff will grade it immediately so that you will know whether you passed. The Engineer will send all the papers to Washington for processing, and if you were satisfactory your combination license will come direct to your home in about six weeks. If you should fail the examination, you have the privilege of taking it again after thirty days — and still again at thirty-day intervals, if necessary.

Code tests are graded as "passed" or "failed," separately for the sending and receiving tests. Failure to pass either will terminate the examination. For written exams, 74 per cent is the passing grade. For the purpose of grading, Examination Elements 2 and 3B, "basic amateur practice" and "general regulations," required for all classes except the Novice, will be considered a single examination. All other elements are graded individually as separate examinations.

Additional Examining Points

There are additional cities visited by traveling FCC inspectors for the purpose of giving examinations, but since such visits are less often than four times per year it is not required that an applicant for General Class appear for a personal examination just because he happens to live within 75 miles of these auxiliary cities. However, since examinations are thus conveniently available to applicants in those vicinities, they are urged to appear for personal examination. Also, applicants living within 75 miles of one of the examining points mentioned earlier, and thereby required to appear for examination instead of taking it by mail, may find one of the cities named below a more convenient place for travel. Examinations are held *twice a year* in the following cities:

Albuquerque, N. M.
Amarillo, Texas
Bakersfield, Calif.
Boise, Idaho
Butte, Mont.
El Paso, Texas
Hartford, Conn,
Hilo, T. H.
Jacksonville, Fla.
Lihue, T. H.
Louisville, Ky.
Portland, Me.
Roanoke, Va.
Spokane, Wash.
Tucson, Ariz.
Wichita, Kans.
Wilmington, N. C.
Wailuku, T. H.

Annual examinations are held in:

Bangor, Maine
Billings, Mont.
Jamestown, N. D.
Klamath Falls, Ore.
Manchester, N. H.
Marquette, Mich.
Rapid City, S. D.
Springfield, Mo.
Tallahassee, Fla.

Elsewhere in this booklet we list alphabetically all the examining points mentioned in previous paragraphs, with as much information as is available at time of publication concerning the schedule of dates on which examinations will be held. Where dates are approximate, exact information can be secured from the Engineer in charge of your district as the time for the examination nears.

Citizens temporarily living outside the United States or possessions, such as military personnel overseas, may apply for licenses by mail; those in the Atlantic region (Europe, Africa) should write to FCC's main office in Washington, D. C.; those in the Caribbean, to FCC's Miami office; those in the Pacific, to Honolulu. Such licenses do not authorize overseas amateur operation, of course, but this procedure is convenient for the person who expects to return home shortly.

Exemptions

Amateurs who are applying for a higher grade of license may receive credit for those portions of the examination already passed if the test was taken before a Commission examiner. There is no credit accruing to licenses issued on the basis of a mail examination. To illustrate, an applicant for Amateur Extra Class privileges who already holds a General Class license needs only to pass the 20-w.p.m. code test and the special written exam on advanced techniques, and receives credit for the standard exam on theory and regulations on the basis of holding a General Class license. The holder of a Conditional Class license gets no credit toward higher grades of license, since his examination was taken by mail. The holder of a Technician Class license applying for a General Class license will get credit for the standard written exam on theory and regulations if he took it in person before a Commission examiner, and has only to pass the 13-w.p.m. code test; if his Technician license was issued on the basis of a mail examination, however, he has to start fresh when he applies for a higher grade.

An applicant for any class of amateur license, except the Extra Class, will be given credit for the code test if within five years he held a commercial radiotelegraph first or second class operator license issued by the Federal Communications Commission.

Persons who held amateur license prior to May, 1917, may have the Amateur Extra Class exam waived as detailed in Chapter 7.

There are no other waivers of examination elements for amateur licenses.

Physical Disability

No physical infirmity is a bar to the issuance of amateur operator and station licenses, provided the applicant can qualify. An invalid or shut-in who lives more than 75 miles from the nearest quarterly examining point will, of course, follow the usual mail procedure (see Chapter 5). But if he lives within the 75-mile limit and is genuinely incapable of traveling, he is similarly entitled under §12.21 to take the mail examination and should request papers therefore from his district Engineer. The application itself must be accompanied by a physician's certificate stating that the applicant is unable to appear for examination because of protracted disability; and sometimes the Engineer will ask to see such a certificate before he will send the examination envelope to a location where normally personal appearance is required. Needless to say, the infirmity must be of a permanent or semipermanent nature; temporary sickness does not entitle one to exemption from appearance.

Some applicants for license, whatever the class, are unable to write out their own examinations in longhand because of blindness or other disability. In such cases, the Commission will permit the applicant to typewrite or dictate the code test and examination answers. If unable to draw the required diagrams, the applicant may instead give a detailed verbal description of them essentially equivalent. When this practice is observed, the witness or examining officer must certify that the examination comprises solely the applicant's efforts or dictation, and that no outside assistance was rendered. The nature of the disability must also be stated and if the examination was dictated the name and address of the person or persons who took and transcribed the dictation must be noted.

Renewals

Provided you can show a certain amount of activity and code ability as an amateur operator, both your operator and station licenses (except Novice Class) may be renewed indefinitely merely upon application. Since the two licenses run concurrently, they are renewed simultaneously.

Proof of activity is not required for the renewal of a station license, but it is essential to the renewal of an operator license, so you had better be thoroughly familiar with the requirements. See §12.27. It is required that you shall have lawfully accumulated a minimum total of either 2 hours operating time during the last 3 months, or 5 hours operating time during the last 12 months, of the license term. This is operating time as shown in your log, or that of any other station you operate, since the work may be accomplished either from your own or any other FCC-licensed amateur station. If you are in contact with another amateur station for a half hour, for example, it counts as a half hour toward your accumulation of time. But two-way communication is not required. For example if you are interested in radio control of remote objects, such as model airplanes, the radio-controlled flying time of such models will count toward your accumulation of activity, providing of course it is properly entered in your log.

It is also required, in applications for renewal, that you affirm your ability to send by hand key and receive by ear, in plain language, messages in the International Morse Code at a speed of at least that which is required in qualifying for an original license of the class being renewed. Hand key is interpreted to include all hand-operated keys — such as semi-automatic keys or "bugs," and electronic keys, in addition to a straight key. Thus for renewal of a Technician license, the applicant would have to affirm code ability of at least 5 words per minute; for Conditional, General and Advanced Classes, 13 words per minute; and for Amateur Extra Class, 20 words per minute.

In applying for straight renewal, use Form 405-A, obtainable from your district Engineer, and file it about 6 weeks before expiration. You will find it consists of three sections, all to be filled out by you carefully and neatly; the first section requires notarization, and then the whole affair is mailed direct to FCC in Washington. Two of the three sections are detached by FCC and become their file records; the third is in the form of a tear-out post card (which you will have already self-addressed) and this FCC authenticates and mails back to you to become a renewal endorsement of your license. Both original license and endorsement of renewal must thereafter be exhibited together as the renewed license authorization. If you have applied before expiration date *for renewal only* (not modifications or other grades) and the Commission is delayed in its processing, you may continue operating past the expiration date until you do hear from FCC. For the record, it is a good idea to note in your log book the date on which application for renewal was filed with the Commission. Incidentally, on Form 405-A, Section 4, the "nature of service" is "Amateur station-and-operator," the "class of station" is of course amateur, the "call sign" is your station call, the "file number" is left blank by amateur applicants, and the "license term ending" is the expiration date of your ticket being renewed.

If several months before expiration you happen to be applying for a modification for change of address, or taking an examination for a higher grade of license, combine the renewal request with your Form 610 filing. Application for renewal may not be made more than 120 days before expiration, however.

If you can't show the required activity, you must qualify for a new license by again taking the amateur examination. You'll get your old call back but meanwhile you'll be off the air. If you fail to file renewal application prior to the date of expiration of your license, you have a period of one year of grace in which you may file renewal application without having to take the amateur examination again. However, you still must be able to show that the required activity took place during the latter part of your license term. Your license will not be valid during this period of grace, and your new license will not be back-dated to the expiration of the old license but will be dated currently.

Modifications

If you change your address permanently, apply for modification of your license to show the new address. This is a factor primarily for station licenses, however, and the procedure is therefore discussed in detail in the section on "modifications" in Chapter 8. It is here to be noted, though, that a license issued in response to an application for modification is no longer valid for an additional five-year term, but bears the same expiration date as the original license of which it is the modified version. Therefore if you should change your address toward the end of your license term, it is desirable to hold off application for modification until you can apply for renewal at the same time — i.e., 120 days prior to expiration. See the discussion under "temporary operation" in Chapter 8 for further details.

Duplicates

If by some chance your license is lost, destroyed, or badly mutilated, you should apply for a duplicate license. The procedure is simple: Write your Engineer for a copy of Application Form 610, and fill it out marking it as an application for duplicate. Explain, in the place provided on the form or on a separate sheet if more space is required, the circumstances under which the license was destroyed or lost — and if it was mutilated, send the license along with the application, also explaining the cause. Mail the application to FCC at Washington.

Qualifying for Higher Grades

An amateur is quite free to apply for a higher grade of license anytime he is able to qualify. The holder of a Novice license may, for example, take the Technician, Conditional (if eligible) or General Class examination any time he wishes — the very next day after he receives his license, for example. In such event, the new license would be really a new one, with the five-year term. When a Conditional or General Class licensee, after having acquired two years' experience, passes the examination for Extra Class license, the "ticket" issued is actually considered by the Commission to be a modification of privileges and is therefore not a new license running for an additional five years but a "modified" license with the original expiration date. In fact, the higher privileges are granted by an endorsement on the original license. A Novice applying for a higher grade license need not, however, submit his Novice ticket with his application.

Examinations for Amateur Extra Class licenses are not available by mail, but must be taken in person at one of the FCC examining points. When examination for a higher grade of license is taken and passed at one of the district offices, the amateur license card is usually endorsed immediately by the Engineer for the new privileges.

Licensing in U. S.-Occupied Countries

In countries occupied by U. S. military forces as an aftermath of World War II, some amateur radio operation is permitted both to members of the U. S. forces and to U. S. civilian personnel. To engage in such operation requires the obtaining of a license from the appropriate area military commander. An examination very similar to the FCC examination must be passed, and the study material in this book is appropriate. Rules and regulations established by the military in the occupied areas closely resemble the FCC regulations. Signal and communications officers in these areas can supply the correct address to which application should be made.

At the present time the various types of military-issued licenses do not include anything similar to the Novice and Technician licenses.

Canada

The frequency bands and general privileges of amateurs in the Dominion of Canada closely parallel those in the United States. However, there is no counterpart in Canada of the extensive U. S. regulations; matters are considerably simpler there. Canadian aspirants to amateur licenses can get full information from the nearest radio inspector or by writing direct to the Telecommunications Division, Department of Transport, at Ottawa.

A special arrangement now exists between Canada and the U. S. providing for operation by amateurs of one country in the territory of the other. Americans may write the above address for application forms which, when filled out and approved and returned, constitute an "endorsement" of the FCC ticket. Similarly, VE amateurs write FCC in Washington for application forms for authorization to operate in U. S. territory. Amateurs with such authorizations must observe the regulations of the country in which they are operating.

Operation in Foreign Countries

Most countries will issue radio licenses only to their own citizens. There are occasions, however, when a certain few will issue amateur authorizations to U. S. citizens. The procedure is often complicated and is subject to change from time to time. If you have plans for visiting or residing in a particular foreign country and wish to investigate the possibility of securing a license to operate in that country, write ARRL Hq. for the latest available information.

Passing the Written Examinations

For each class of amateur operator license there is a written examination, varying in scope in accordance with the privileges each license grants. For the most part these questions are the quickly answered "multiple-choice" type (explained in detail in the next paragraph) which require merely that the applicant indicate the correct one of several suggested answers. Some of these require simple mathematical calculations, in addition to which there are some questions — not of the multiple-choice type — which also require the solution of simple problems in arithmetic; finally, some of the questions (except those in the Novice exam) involve the drawing of a requested circuit diagram.

A word about the "multiple-choice" type of query. This is the kind frequently used in current-events quizzes, where a question is asked and four or five possible answers given, one of which, *and only one*, is correct. In answering such a question, it is necessary only to indicate which is the correct answer; no explanation or comment is required. In the amateur examination, each of the possible answers is numbered, and a space is left at the right-hand side of the sheet in which the applicant puts down the number of the correct answer. Two types of multiple-choice questions, with the correct answer designated in each case, are as follows:

A. San Francisco is located in:
   1. Nebraska.
   2. New York.
   3. Oregon. (Correct answer number
   4. California. indicated here)
   5. Texas. *4*

B. San Francisco is *not* located in:
   1. The Western Hemisphere.
   2. The United States.
   3. North America. (Correct answer number
   4. California. ber indicated here)
   5. Canada. *5*

As is apparent, the number put down must be either 100% right or 100% wrong. There is no opportunity for part credit on questions; an applicant gets either full credit for correct answer or no credit at all for an incorrect one. For the person who is adequately prepared, an examination of this type is easier than the "essay" type. It is also fairer in that the personal opinion of the examiner cannot enter as a factor; there is thus no possibility of being "docked" part credit because a particular examiner might regard an answer as insufficiently detailed, etc., as could be the case in connection with the essay-type reply.

The questions and answers in this booklet are designed to give you all the knowledge you need to answer correctly the actual examination questions. But it should be emphasized that *the questions we list here are not the actual questions in the license examination*, nor do they correspond question-for question to similar examination items. What they are, however, are carefully prepared items designed to insure that you have the necessary knowledge to cope with the actual test queries. For instance, the examination might have a question or a problem which involved the use of Ohm's Law to answer properly. Without in any way duplicating that particular problem, or even its type, a question could be devised which made it necessary for the student to learn the use of Ohm's Law to the extent required in the examination. Similarly, if we give a question here requiring that the student draw the diagram of a multistage r.f. amplifier, it is a fair assumption he would subsequently be able to draw diagrams of any one of its individual stages.

To the questions asked in this booklet we give carefully-considered answers which naturally take the form of brief discussions. Where the subject needs a little more explanation you will find a note appended, as in the questions involving arithmetic, where we show how the computation is made. But bear in mind that your actual examination will be in the multiple-answer form and that you will not have to write out a response but will simply identify the answer you perceive to be correct. There may be several questions in the actual examination revolving around one simple discussion in this manual, but when you understand the subject you can readily check off answers to any number of questions on it. If our answers sometimes seem to the initiated to be naïve or incomplete, rest assured that they are sufficient for the purpose. You may similarly encounter several demands for circuit drawing derived from a single one of our drawings, but if you know the whole circuit you know all its parts.

In other words, the purpose of this manual is not to give the student the actual questions he will meet but to equip him with the knowledge he must have to pass the examination. In order to familiarize himself with the underlying principles, we also suggest a study of *The Radio Amateur's Handbook*, particularly those chapters — depending upon the license being applied for — dealing with elementary electrical and radio principles, basic transmitter, radio-frequency, audio-frequency and power-supply circuits, frequency-measuring and monitoring equipment, and radiotelephony.

The Novice License

• The Novice Class license offers an ideal way to get started in amateur radio — reduced code speed and simplified written examination. It grants a portion of amateur privileges on an "apprenticeship" basis for one year. The examination is available only by mail. This chapter explains the license in detail and contains sample questions for the written exam.

As an incentive to encourage a greater number of people to engage in the hobby of amateur radio, the Federal Communications Commission has established a Novice Class of license with greatly reduced requirements and only a few of the privileges available to amateurs. This class of license might well be termed an apprenticeship. It has a term of but one year, compared with the five-year terms of other amateur licenses, and the objective is to give a newcomer a period of a year of actual on-the-air experience or training in amateur operation so that he may develop his skills toward one of the permanent classes of license more rapidly than he would by textbook study and audio-oscillator code practice.

The Novice Class license examination may now be taken only by mail, under the direct supervision of an amateur holding a General Class license or higher, or a commercial radiotelegraph license. This is true no matter where the applicant lives. Refer to the section "Examination Procedures" in Chapter 5 for details on the rules governing the routine for making application and obtaining a set of examination papers.

Requirements for the Novice license are the passing of a code test in sending and receiving at the rate of 5 words per minute, and a written examination in the most elementary aspects of amateur regulations and theory.

The privileges which are currently available to the Novice licensee are:

3700–3750 kc. — telegraphy
7175–7200 kc. — telegraphy
21,100–21,250 kc. — telegraphy
145–147 Mc. — telegraphy or voice

In addition, the transmitter used by a Novice licensee must be crystal-controlled, and may not have an input exceeding 75 watts. Of course, the Novice may operate portable or mobile on any of these frequencies (See Chapter 8).

The most important point concerning the Novice license is that it is valid for only one year and may not be renewed. Before the end of his license term the Novice must qualify for one of the other grades of amateur license, or go off the air. He may try for a General Class license (or Conditional Class, if eligible to take the mail examination) in which case he must pass the standard amateur examination, both 13 words per minute in code and the regular exam on theory and regulations. Or he may try for a Technician license, in which case he gets credit for the code test (if the test was taken before an FCC examiner) and has to pass only the additional standard exam on theory and regulations. He may not try for a class higher than those mentioned, of course, since experience as a Novice operator does not qualify for the service requirements for the Extra Class license.

Anyone who is a citizen of the United States may apply for the Novice license. except a person who holds or ever has held an amateur license of any class. Thus a Novice not only is unable to renew his license at the end of its term, but he may not again apply for Novice privileges. If an applicant for Novice privileges feels that he can pass the standard written examination for amateur licenses but is unable to meet the 13 w.p.m. code requirement, he may simultaneously apply also for the Technician Class of license, taking the 5 w.p.m. code test, the elementary Novice written exam, and the standard written exam.

A Novice may operate any FCC-licensed amateur radio station, but only to the extent of the privileges available to the Novice and similarly available to the licensee of the station being operated. For example, he may visit a station licensed to a Conditional, General, Advanced or Extra Class licensee, and operate it provided the transmitter is crystal-controlled, is limited to 75 watts input or less, and is working in the bands specified for the Novice. A Novice may not operate a station licensed to a Technician, since the latter's privileges do not include Novice bands; similarly, a Technician may not operate a station licensed to a Novice, since the Technician's operator authority does not extend to the Novice bands, and the Novice's station license does not grant authority to work above 220 Mc.

As stated, the written examination for the Novice license is quite simple. It consists of about 20 questions dealing with basic amateur regulations, and certain points of theory and technique. The questions are of the "multiple-choice" type, as explained in Chapter 1. There are no diagrams required. Following is a set of questions similar to those which are asked in the examination. If you are thoroughly able to answer each of these sample questions, you will have no difficulty in passing the written exam. However, in any event we recommend additional study of at least the technical material in *How to Become a Radio Amateur* (50¢) and preferably of the introductory chapters of *The Radio Amateur's Handbook* ($3.00), both available postpaid from the ARRL, West Hartford 7, Conn.

The receiving code test for the Novice Class license consists of 25 five-letter words, mostly common ones. No punctuation marks or numerals are included. To pass, the applicant must copy at least 25 consecutive letters accurately. In the sending test, numerals and simple punctuation marks may be included.

(The references in parentheses at the end of answers to regulatory questions are to appropriate sections of the amateur rules or the Communications Act.)

1. What is the maximum input power permitted to the final stage of the transmitter in a station licensed to the holder of a Novice Class license or operated by such an operator?

The maximum input power permitted a Novice is 75 watts. (§12.23)

2. What is the maximum penalty for a violation of the rules and regulations of the Federal Communications Commission?

A fine of up to $500 for each day during which the offense occurs, suspension of operator license, and revocation of station license. (Act, §502)

3. On what frequency bands may the holder of a Novice Class license operate an amateur radio station?

3700–3750 kc.
7175–7200 kc.
21,100–21,250 kc.
145–147 Mc.
(§12.23)

4. On what frequency bands may the holder of a Novice Class license operate an amateur radiotelephone station?

145–147 Mc. (§12.23)

5. What is the log of an amateur station, and what information is required to be entered therein? How long must it be preserved?

The log of an amateur station is the written record of transmissions. The log must show:

1) the date and time of transmission
2) the signature of each licensed operator operating the equipment and the name of any person not holding a license who speaks over a radiotelephone transmitter
3) call of the station called
4) the input power to the transmitter
5) the frequency band used
6) the type of emission used
7) the location of the station at the time of transmission
8) the message traffic handled

Information such as the input power, frequency band, type of emission, location of station, need be entered only once provided the conditions are not changed. Similarly, one entry of the date need not be repeated for other transmissions made on that date. If the station is mobile, the approximate geographic location can be indicated in the log.

The log of an amateur station must be preserved for at least one year following the last date of entry. Similarly, any message traffic handled must be kept on file for at least one year. (§12.136)

6. What is the term of an amateur Novice Class license? Under what conditions may this license be renewed?

The term of an amateur Novice Class license is one year. (§12.29)

It may not be renewed under any conditions. [§12.27(b)]

7. What are the rules and regulations regarding the transmission of improper language, false signals, or malicious interference?

The transmission of obscene, indecent or profane language, or of false or deceptive signals or call letters, or of malicious interference is expressly prohibited and there are heavy penalties for violation. (§§12.157, 12.158, 12.160)

8. What are the rules and regulations regarding purity and stability of emissions?

Below 144 megacycles, spurious radiations must be reduced in accordance with good engineering practice, and must not cause interference to near-by receivers of good engineering design not tuned to the transmitter. Voice modulation of a transmitter must not cause spurious emissions; the maximum modulation percentage is 100. Simultaneous frequency modulation and amplitude modulation is not permitted. The frequency of the signal transmitted must be as constant as the state of the art permits. (§12.133)

9. What method of frequency control is required to be used in the transmitter of a station licensed to the holder of a Novice Class license?

The frequency must be crystal-controlled. (§12.23)

10. What are the rules and regulations regarding the measurement of the frequencies of the emissions of an amateur radio station?

Regular measurement of the frequency of the transmitter is required. This measurement must be by means independent of the means used to control the transmitting frequency and must be of sufficient accuracy to ensure operation within the frequency band used. (§12.135)

11. Who may be permitted to operate the transmitter of an amateur radio station licensed to the holder of a Novice Class license?

Any amateur radio operator except of the Technician Class. (§12.28)

12. Under what circumstances may an amateur radio station be used by a person who does not hold a valid license?

A person not properly licensed may not *operate* an amateur station. However, he may speak over the microphone of an amateur radiotelephone station provided a duly-licensed operator is present to control the emissions. (§12.28)

13. What is the maximum permissible percentage of modulation of an amateur radiotelephone station?

One hundred per cent. (§12.133)

14. At what intervals must an amateur station be identified by the transmission of its call sign? May any transmission be made without identification of the station?

An amateur station must identify its call sign at the beginning and end of each transmission and at least every ten minutes if a single transmission lasts longer than ten minutes. No transmission by itself may be made without identification of the station, except that during a sequence of transmissions each less than three minutes long, the call sign needs to be given only once each ten minutes as well as at the beginning and end of the work. (§12.82)

15. Under what conditions is notice of portable or mobile operation required to be given, and to whom in each case?

Notice of intended portable operation, or mobile operation, must be given the FCC Engineer-in-Charge of the inspection district in which such portable or mobile operation is contemplated only when the operation is or is expected to be for a period longer than 48 hours. (§12.91)

16. What are the recognized abbreviations for: kilocycles, megacycles, Eastern Standard Time, Greenwich Mean Time, continuous wave, frequency modulation, amplitude modulation?

kilocycles — kc.
megacycles — Mc.
Eastern Standard Time — EST
Greenwich Mean Time — GMT
continuous wave — c.w.
frequency modulation — f.m.
amplitude modulation — a.m.

17. What is the relationship between a fundamental frequency and its second harmonic; its third harmonic, etc.?

The second harmonic is twice the frequency of the fundamental, the third harmonic is three times the fundamental frequency, and so on. A harmonic is always related to its fundamental frequency by an integral multiplier; i.e., 2, 3, 4, 5, 6, etc.

18. What is the relationship between a cycle, a kilocycle, and a megacycle?

1 kilocycle = 1000 cycles
1 megacycle = 1000 kilocycles = 1,000,000 cycles

19. What instrument is used to measure: electrical potential; electrical current; electrical power; electrical energy?

Electrical potential is measured by a voltmeter.

Electrical current is measured by an ammeter, milliammeter, or microammeter.

Electrical power is measured by a wattmeter.

Electrical energy is measured by a watt-hour meter.

20. What is the purpose of: a modulator; an amplifier; a rectifier; a filter?

A modulator is used to vary the amplitude, frequency or phase of the radio-frequency output of a transmitter for the purpose of transmitting information.

An amplifier is used to increase the amplitude, or power level, of a signal.

A rectifier is used to change alternating current into pulsating direct current.

The purpose of a filter is to attenuate undesired frequencies while simultaneously passing, without appreciable attenuation, a desired band of frequencies and/or direct current. *Examples:* The power-supply "smoothing filter," which eliminates the alternating-current ripple from the output of a rectifier but permits direct current to flow with little or no attenuation; the "low-pass" filter, which attenuates all frequencies (such as harmonics in the output of a transmitter) above a given frequency but passes all lower frequencies.

21. What is meant by: amplification; modulation; detection; attenuation?

Amplification is the process of increasing the amplitude, or power level, of a signal.

Modulation is the process of varying the amplitude, frequency or phase of the radio-frequency output of a transmitter. Modulation is normally employed for the purpose of transmitting information. However, it may also occur inadvertently, as in the case of "hum" modulation of a signal resulting from ripple in the output of an insufficiently-filtered d.c. power supply.

Detection or demodulation is the process of extracting the information contained in the modulation on a radio-frequency signal.

Attenuation is a reduction in amplitude.

22. What is the purpose of: a radio-frequency choke; an audio-frequency choke; a filter choke?

The purpose of a radio-frequency choke is to oppose the flow of radio-frequency current while permitting direct current and audio frequencies to flow without appreciable opposition.

The purpose of an audio-frequency choke is to oppose the flow of audio-frequency currents while permitting direct current to flow.

The purpose of a filter choke is to aid in smoothing the direct-current output of a rectifier.

23. How is the actual power input to the tube or tubes supplying energy to the antenna of an amateur transmitter determined?

The input power is determined by measuring the direct-current plate voltage and the d.c. plate current to the tube or tubes in the final stage in the transmitter. The power input is equal to the plate voltage multiplied by the plate current in amperes. *Example:* Two tubes in the final stage of the transmitter take 50 milliamperes each, at a plate voltage of 500 volts. The total plate current is $2 \times 50 = 100$ milliamperes, or 0.1 ampere. The power input is therefore $500 \times 0.1 = 50$ watts.

24. Why are a rectifier and filter required in the plate power supply system of an amateur transmitter when operated from alternating current?

The amateur regulations require that an adequately-filtered plate supply be used on transmitters operating below 144 Mc. The rectifier is used to convert the alternating current into direct current. However, its d.c. output is pulsating, not constant, and the filter must be used to smooth out the pulsations so that the output is essentially "pure" — that is free from pulsations or "ripple."

25. What is a frequency multiplier?

A frequency multiplier is a device that delivers output at an integral multiple (i.e., 2, 3, 4 times, etc.) of the applied frequency. The output of a frequency multiplier is consequently on a frequency that is a harmonic of the fundamental (applied) frequency.

26. What are the undesirable effects of overmodulation in radiotelephony?

Overmodulation results in the generation of spurious sidebands — that is, frequencies lying outside the band of frequencies or "channel" actually required for transmitting the information contained in the modulation. These spurious frequencies, called "splatter," will interfere with communication on near-by channels and may even lie outside an amateur band. At close range they may also cause interference with broadcast reception.

27. What is meant by a "parasitic" oscillation?

A parasitic oscillation is one not essential to the operation of the equipment and usually occurring on a frequency considerably removed from the operating frequency.

28. What is the purpose of a "key-click filter" and when should it be used?

The purpose of a key-click filter is to reduce spurious radiation generated when keying a radiotelegraph transmitter. It should be used whenever required for suppressing such spurious radiations.

29. What is Ohm's Law?

Ohm's Law expresses the relationship between potential, current and resistance in any circuit. It is stated as

$$I = \frac{E}{R}, \text{ where } \begin{aligned} I &= \text{current in amperes} \\ E &= \text{potential in volts} \\ R &= \text{resistance in ohms} \end{aligned}$$

By simple algebra it is also $E = IR$ and $R = \frac{E}{I}$

30. What precautions should be taken to avoid the danger of shock from high-voltage electrical circuits?

Such circuits in transmitters and receivers should not be exposed where the operator can inadvertently come in contact with them when the power is turned on. All work on equipment involving the possibility of contact with such circuits should be done only after the power has been turned off. All power-supply condensers should have bleeder resistors connected across them, to discharge the condensers after the power has been turned off.

31. What is the relationship between the frequency and the wavelength of a radio wave if its velocity in space is 300,000,000 meters per second?

The frequency in cycles multiplied by the wavelength in meters is 300,000,000. Therefore, the wavelength is inversely proportional to the frequency; in other words, the longer the wavelength, the lower the frequency. The formula for calculating frequency (f) in cycles when the wavelength in meters is known is $f = \frac{300,000,000}{\text{Wavelength}}$; similarly, wavelength $= \frac{300,000,000}{f}$.

(Example: The wavelength of a signal whose frequency is 3700 kilocycles is $\frac{300,000,000}{3,700,000}$ or $\frac{300,000}{3,700}$ or 81.08 meters.)

32. What symbol is used in the amateur rules to designate amplitude-modulated telegraphy without the use of modulating audio frequencies (on-off keying)?

A1. (The "A" indicates amplitude modulation, and the numeral "1" is used to indicate telegraphy by on-off keying).

33. What is the ruling regarding eligibility for reëxamination?

An applicant who fails an operator examination may not take another examination for such privileges within 30 days (except that this does not apply to an examination for a General Class license following an examination for a Conditional Class license).

The Technician License

For the purpose of encouraging a greater interest among would-be amateurs in experimentation on and development of the higher radio frequencies, the Federal Communications Commission has established the Technician Class of amateur license.

Any citizen of the United States may apply. The requirements are the standard written examination on theory and regulations, and a code test in sending and receiving at the rate of 5 words per minute. Since an amateur radio license is necessary to operate all forms of radio controlled models, the Technician Class license should be of special interest to those hobbyists interested in radio control of airplanes, boats and cars.

The privileges available to the Technician are all those amateur privileges above 220 Mc., using any type of emission permitted in the band in which he is operating. The frequency bands open to the Technician licensee are:

6 meters
220–225 megacyles
420–450 megacycles [1]
1215–1300 megacycles
2300–2450 megacycles
3300–3500 megacycles
5650–5925 megacycles
10,000–10,500 megacycles
21,000–22,000 megacycles
30,000 megacycles and above

The following types of emission are permitted in these bands:

A-0	Steady unmodulated pure carrier
A-1	Telegraphy on pure continuous wave
A-2	Amplitude tone-modulated telegraphy
A-3	Amplitude-modulated telephony
A-4	Facsimile
A-5	Television (except in 220–225 Mc.)

In addition, frequency modulation may be used on the above bands and pulse emission employed on the indicated frequencies above 2300 Mc.

• The Technician Class license is designed to encourage amateur experimentation in the very-high and ultra-high frequency portions of the spectrum. The examination is available by mail only. This chapter explains the license in detail.

The Technician Class license examination may now be taken only by mail, under the direct supervision of an amateur holding a General Class license or higher, or a commercial radiotelegraph license. This is true no matter where the applicant lives. Refer to the section "Examination Procedures" in Chapter 5 for details on the rules governing the routine for making application and obtaining a set of examination papers.

If the Technician later applies for a General Class license, he will get credit for the written examination if he originally passed it in person before an FCC examiner, but will not get credit if his exam was taken by mail. Of course, if a Technician wants "standard" amateur privileges and is eligible for a mail examination by reason of distance from a quarterly examination point, or physical disability, or military service, he may take the Conditional Class exam by mail and receive the same privileges.

A Technician may operate any other amateur radio station licensed by FCC so long as that station is operated in the amateur bands above 220 Mc.

The written examination for the Technician license is identical to that for the General Class. Therefore, the sample question-and-answer material in Chapter 4 is directly applicable.

The term of the Technician Class license is five years, and it may be renewed upon proper application provided you can show the required proof of operating activity.

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[1] Peak antenna power must not exceed 50 watts.

CHAPTER 4

The General Class License

The General Class license might be termed the "standard" amateur license. It was formerly known as Class B. It requires the passing of a code test at a rate of 13 words per minute, both sending and receiving, and of a written examination in basic theory and regulations. It conveys all amateur privileges; there are no longer any suballocations for voice emission restricted to holders of advanced-grade licenses.

Applicants for the General Class license must take the examination before an FCC representative at any one of the points mentioned in Chapter 1. If an applicant lives more than 75 miles airline from a quarterly examination point, or is physically disabled, or in military service and unable to appear, he is eligible to take the examination by mail but in that event he is issued a Conditional Class license, which conveys exactly the same privileges. (See Chapter 5.) A holder of a General Class license applying for a higher grade will receive credit for any portions of the higher class license requirements which were originally passed for his General Class privileges, but the holder of a Conditional Class license gets no such credit and has to go through the entire exam as required.

The term of the General Class license is five years. It may be renewed upon proper application provided you can show the required proof of operating activity. This of course is in the new terms of either 2 hours operating time during the last 3 months, or 5 hours operating time during the last 12 months, of the license term — rather than the three c.w. contacts previously required. It is also necessary to affirm that you can send and receive code at a rate of at least that speed originally required for the class of license being renewed — in this case 13 words per minute.

A General Class licensee may operate any FCC-licensed amateur station — his own or a friend's — on any amateur frequency and with any type of emission permitted under the regulations.

A General Class license is one of the three amateur grades (the other two being Advanced and Amateur Extra Class) whose holders are permitted to conduct and supervise the code test — and the written examination as well, if the holder is more than 21 years of age — for the Novice, Technician and Conditional Classes of license available by mail. (See Chapter 5.)

• The sample questions and answers in this chapter are those covering examination Elements 2 — basic amateur practice — and 3B — general regulations. These elements, as a single written examination, are required not only for the General Class license but also for the Technician and Conditional Classes. They are also required for the Amateur Extra Class, if credit therefor does not already exist by virtue of having passed them before an FCC examiner in connection with a currently-held license of lower grade.

The written examination for the General Class license covers both Element 2 — basic amateur practice — and Element 3B — general regulations. It is a "combined" examination and is graded as a unit, 74 per cent being the required passing grade. The exam consists of about 50 questions, mostly of the "multiple-choice" type explained in Chapter 1, but including also some diagrams. Approximately two-thirds of the questions are on technical subjects; the remainder concern themselves with amateur regulations.

The following sample questions are not those on the actual examination, but indicate the nature of questions which will be asked and cover the field sufficiently so that if you are able to answer each one shown here, you need have no fear of passing the written portion of the exam. As can be seen from an inspection of the questions, they cover a "sampling" in each of the numerous technical and regulatory fields. As for all amateur written examinations, we recommend additional supplementary study, in this case the appropriate chapters of *The Radio Amateur's Handbook* and of the actual amateur regulations printed in Chapter 10 of this booklet. For the latter purpose, answers to sample questions dealing with regulatory matters include references to the section number of the specific amateur regulation covering.

Questions and Answers Covering Examination Element 2 – Basic Amateur Practice and Examination Element 3B – General Regulations

1. Name the basic units of electrical resistance, inductance, capacitance, current, electromotive force or potential difference, power, energy, quantity, magneto-motive force, and frequency.

The unit of electrical resistance is the ohm.

The unit of inductance is the henry.

The unit of capacitance is the farad.

The unit of current is the ampere.

The unit of electromotive force or potential difference is the volt.

The unit of power is the watt.

The unit of energy is the joule.

The unit of quantity is the coulomb.

The unit of magneto-motive force is the gilbert.

The unit of frequency is cycles-per-second or, simply, cycles.

2. Name the instruments normally used to measure (a) electric currents; (b) potential difference; (c) power; (d) resistance; (e) frequency.

(a) Electric current is measured by an ammeter; (b) potential difference by a voltmeter; (c) power by a wattmeter; (d) resistance by an ohmmeter; and (e) frequency by a frequency-meter.

3. How may plate power input of an amplifier be determined when the plate voltage and plate current are known?

The plate power input of an amplifier in watts is equal to the product of the plate voltage in volts and the plate current in amperes.

Note: For example, the power input to an amplifier operating at a plate voltage of 1000 volts with plate current of 125 milliamperes (0.125 ampere) would be 125 watts.

4. Explain the purpose of using a center-tap return connection on the secondary of a transmitting tube's filament transformer.

A center-tap return connection for the grid and the plate circuit is provided on the secondary of a transmitting tube's filament transformer to prevent modulation of the emitted wave by the alternating-current filament supply.

5. If the high-voltage secondary of a plate transformer were changed from a full-wave center-tapped to a bridge rectifier connection, what would be the relative voltage and current output ratings as compared to those for the full-wave center-tapped connection?

With the bridge connection the output-voltage rating would be double while the current rating would be half that for the center-tapped connection. In consequence, filter condensers of twice the voltage rating would be required for the bridge connection, while the filter choke might have one-half the current rating for full output.

6. Why is it advisable to use a plate power supply for the oscillator of a transmitter separate from the final amplifier plate power supply?

It is advisable to use a separate plate power supply for the oscillator because frequency modulation of the emitted carrier is likely to occur with a power supply common to the oscillator and other stages of the transmitter — because of plate-voltage variations with changing load.

7. How does a swinging choke operate to improve the voltage regulation of a plate-supply filter system?

The swinging choke provides increased inductance with decreasing load current thus tending to keep the output voltage constant with varying load.

8. Why is full-wave rectification generally preferable to half-wave rectification in a power supply?

Full-wave rectification is generally preferable because the output is easier to filter as a consequence of the higher ripple frequency.

9. What are the relative advantages and disadvantages of mercury-vapor and high-vacuum rectifiers of equivalent filament ratings?

The mercury-vapor rectifier has a lower internal voltage drop of nearly constant value, along with a relatively high current rating. However, the mercury-vapor rectifier also has a critical inverse peak voltage rating and a critical peak-current rating which must not be exceeded in operation. Because of the critical peak-current rating it is not advisable to use mercury-vapor type tubes with condenser-input filters. On the other hand, while the high-vacuum type rectifier has a greater internal voltage drop, the inverse peak-voltage rating is limited only by the insulation within the tube and it does not have a critical peak-current rating, so that it may be used safely with a condenser-input filter.

10. What are the principal output-voltage ripple frequencies with half-wave and full-wave single-phase rectifiers, in terms of the a.c. supply frequency?

With a half-wave rectifier, the principal output ripple frequency is equal to the alternating-current supply frequency; while with a full-wave single-phase rectifier the principal output ripple frequency is twice the a.c. supply frequency.

11. What is the principal reason for using a filter in a plate power-supply system?

The principal reason for using a filter in a plate power-supply system is to smooth out the a.c. ripple component in the output and make it "pure d.c."

12. What would be a suitable type and the approximate capacitance of the filter condensers in a typical 1000-volt transmitter plate-supply system?

Suitable types of filter condensers would be paper, oil-filled, or pyranol types of 2- to 4-μfd. capacitance with a working voltage of more than 1000 volts.

13. What would be the visible operating results of a short-circuited filter condenser in a plate power supply with an unfused primary circuit?

With high-vacuum type rectifier tubes the plates would become red hot, while with mercury-vapor rectifiers the normal bluish-green glow would become considerably brighter.

14. Why should a fuse be used in the transformer primary circuit of a power-supply system?

A fuse should be used in the transformer primary circuit to prevent damage to the power supply from overload.

15. Why is a bleeder resistor connected across the output circuit of a high-voltage power-supply system?

A bleeder resistor is used to give better voltage regulation by providing a minimum fixed load on the power supply.

16. What would happen if the primary of a 60-cycle power supply was connected to mains carrying continuous direct current?

With d.c. applied, excessive current would flow in the primary winding of the power transformer.

17. What is the principal advantage of a screen-grid type r.f. amplifier tube over a triode of equal output rating?

The principal advantage of the screen-grid type tube is that it does not require an external neutralizing circuit because the screen-grid reduces the effective capacitance between the control grid and plate to a very small value.

18. What tube rating indicates the maximum safe heat radiation capability of the anode of a vacuum tube?

The maximum safe heat radiation capability of the anode is indicated by the "maximum plate dissipation" rating, expressed in watts.

19. In the classification of tubes according to the number of elements, how many grids has each of the following types: (a) diode; (b) triode; (c) tetrode; (d) pentode; (e) heptode?

(a) Diode, no grid; (b) triode, one grid; (c) tetrode, two grids; (d) pentode, three grids; (e) heptode, four or five grids, depending upon the type.

Note: For each type, with the possible exception of the heptode, the number of grids is two less than the total number of elements in the tube as indicated by the general type name. The diode has two elements; the triode, three elements; the tetrode, four elements; the pentode, five elements; and the heptode, seven elements.

20. Describe the adjustment procedure for proper neutralization in a radio-frequency power amplifier using an r.f. indicator coupled to the plate tank circuit.

The adjustment procedure for proper neutralization is as follows: The plate voltage is first removed from the tube or tubes of the stage to be neutralized. This is an especially important precaution, because the amplifier cannot be neutralized with plate voltage applied. The input and output circuits are then tuned to resonance with the excitation frequency, as indicated by maximum reading of the r.f. indicator coupled to the plate tank circuit. The neutralizing condenser or condensers are then adjusted, while the input and output circuits are tuned to resonance, until the r.f. indicator shows that there is no r.f. power in the plate tank circuit.

21. Why is it necessary to neutralize a triode radio-frequency power amplifier operating with input and output circuits tuned to the same frequency?

The triode r.f. amplifier must be neutralized to prevent self-oscillation.

22. What undesirable effects may result from operation of an unneutralized triode r.f. amplifier in a transmitter?

Self-oscillation may result, with consequent radiation on undesired frequencies, possibly outside an amateur band.

23. What undesirable effects result from frequency-modulation of an amplitude-modulated carrier wave?

Such unintentional frequency-modulation of an a.m. signal causes spurious sidebands ("broad signals") and unnecessary interference.

24. What operating conditions would be favorable for harmonic generation in a radio-frequency doubler or frequency-multiplying amplifier?

Operating conditions encouraging harmonic generation are high negative-grid bias, with ample excitation, and a high-impedance plate circuit tuned to twice the excitation frequency (one-half the wavelength of the excitation voltage).

25. Where is link coupling applicable in an oscillator-amplifier type transmitter?

Link coupling may be used between the oscillator and buffer stage, between two r.f. amplifier stages, or between the output stage and the antenna coupling network.

26. What is the purpose of a Faraday (electrostatic) shield between the output circuit of an r.f. power amplifier and antenna coupling system?

A Faraday (electrostatic) shield is used to reduce undesirable harmonic transfer and radiation which otherwise might result from capacitive coupling.

27. What are the output circuit conditions for obtaining optimum power output from a radio-frequency amplifier?

Optimum power output is obtained when the output circuit impedance is matched to the rated tube load impedance.

Note: Optimum power output is the maximum power obtainable with reasonably good efficiency and reasonable small distortion (low harmonic content).

28. In which stage of a transmitter is an amplifier of high harmonic output least desirable?

An amplifier of high harmonic output is least desirable in the output stage of a transmitter because radiation of spurious harmonic frequencies may result, especially when the tank circuit is directly coupled to the antenna system.

29. What are the relative plate current indications for resonance and off-resonance tuning of the plate tank circuit of a radio-frequency power amplifier?

The plate current is minimum at resonance and rises suddenly to an excessive value at off-resonance tuning.

30. What are the advantages of a push-pull r.f. power amplifier output stage as compared to a single-ended stage of the same power?

One advantage of a push-pull r.f. amplifier is that even harmonics of the excitation frequency are suppressed by cancellation in the output circuit. Another is that more complete neutralization usually can be obtained than with a single-ended amplifier.

31. A 2000-kc. low-drift crystal having a negative temperature coefficient of 5 cycles per megacycle per degree Centigrade is started in operation at 40 degrees Centigrade. If the temperature-frequency characteristic is linear, what will the oscillation frequency be at a temperature of 60 degrees Centigrade?

The oscillation frequency at 60 degrees Centigrade is 1999.8 kc.

Note: "Negative temperature coefficient" means that the oscillation frequency *decreases* with rise in temperature. "5 cycles per megacycle" means 5 cycles per megacycle of the specified calibration frequency of the crystal (in other words, 5 parts per million). 1 Mc. = 1000 kc. The total frequency *decrease* is therefore $5 \times 2 \times (60 - 40) = 200$ cycles = 0.2 kc. The final oscillation frequency is therefore 2000 kc. − 0.2 kc. = 1999.8 kc.

32. A low-drift crystal for the 3500–4000 kc. amateur band is guaranteed by a manufacturer to be calibrated to within 0.04% of its specified frequency. Desiring to operate as close to the lower band limit of 3500 kc. as safely as possible, for what whole-number kilocycle frequency should you order your crystal, allowing 1 kc. additional for variation from temperature and circuit constants?

The crystal should be ordered for a frequency of 3503 kc.

Note: The formula for calculation of the precise crystal frequency for operation as near as possible to the *low-frequency* end of a band is

$$f_x = \frac{f_L}{1 - n} + k$$

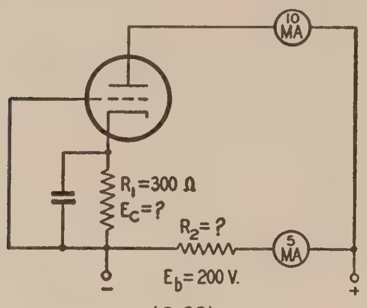
where f_x is the crystal frequency
f_L is the lower band-limit frequency
n is the calibration tolerance, expressed as a decimal
k is the frequency range allowed for temperature and circuit variation.

In this case,

$$f_x = \frac{3500}{1 - 0.0004} + 1 = \frac{3500}{0.9996} + 1 = 3501.4$$
$$+ 1 = 3502.4 \text{ kc.}$$

The nearest whole-number kilocycle frequency safely inside the band for the specified tolerance with the additional allowance of 1 kc. is therefore 3503 kc. (*not* 3502 kc.).

33. In the circuit diagram below, what is the value of the bias voltage? What is the value of the bleeder resistance, R_2?



(Q 33)

The bias voltage, E_c, is 3 volts.

The value of the bleeder resistance, R_2, is 40,000 ohms.

Note: The cathode current is the same as the plate current.

Hence $I_c = 10$ ma. $= 0.01$ amp.

By Ohm's Law, $E_c = I_c\ R_1 = 0.01 \times 300 =$ 3 volts.

Also by Ohm's Law, $R_2 = \frac{E_b}{I_b} = \frac{200}{0.005} = 40{,}000$ ohms

where I_b is the bleeder current $=$ 5 ma. $=$ 0.005 amp.

34. A certain 1750-kc. Y-cut quartz crystal has a positive temperature coefficient of 125 cycles per degree Centigrade and is started in operation at 40 degrees Centigrade. If the temperature-frequency characteristic is linear, what will the oscillation frequency be at a temperature of 60 degrees Centigrade?

The final oscillation frequency is 1752.5 kc.

Note: "Positive temperature coefficient" means that the oscillation frequency *increases* with rise in temperature. The total change in temperature is 60° − 40° = 20° C. The total frequency increase is therefore 125 × 20 = 2500 cycles per second, or 2.5 kc. The final oscillation frequency is 1750 kc. + 2.5 kc. = 1752.5 kc.

35. For what frequency should you order your crystal for operation as close as safely possible to the upper band limit of 4000 kc., with the same calibration accuracy and allowance given in Question 32?

The crystal should be ordered for a specified frequency of 3997 kc.

Note: The formula for calculation of the precise crystal frequency for operation as near as possible to the *high-frequency* end of the band is

$$f_x = \frac{f_U}{1+n} - k$$

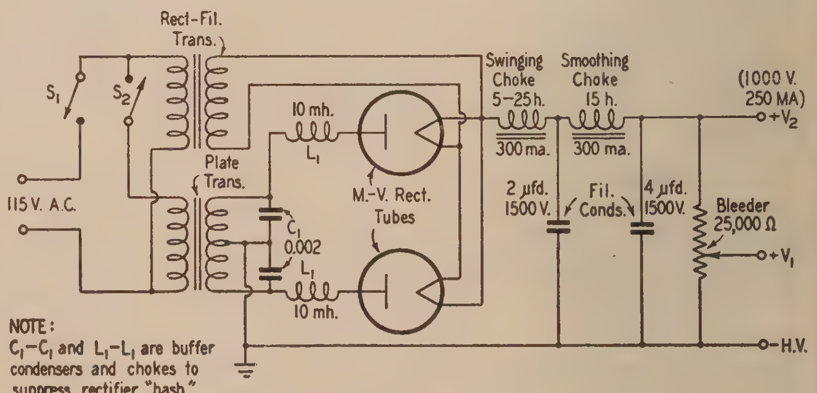
where f_x is the crystal frequency
f_U is the upper band-limit frequency
n is the calibration tolerance, expressed as a decimal
k is the frequency allowance for temperature and circuit variation.

In this case,

$$f_x = \frac{4000}{1.0004} - = 3998.4 - 1 = 3997.4 \text{ kc.}$$

The nearest whole-number kilocycle frequency safely inside the band for the specified tolerance and additional frequency allowance is therefore 3997 kc.

36. Draw a schematic diagram of a full-wave single-phase power supply using a center-tapped high-voltage secondary with a filter circuit for best regulation, showing a bleeder resistor providing two different output voltages and a method of suppressing "hash" interference from the mercury-vapor rectifier tubes. Give the names of the component parts and approximate values of filter components suitable for either amateur radiotelephone or radiotelegraph operation.



NOTE:
C_1–C_1 and L_1–L_1 are buffer condensers and chokes to suppress rectifier "hash."

(Q 36)

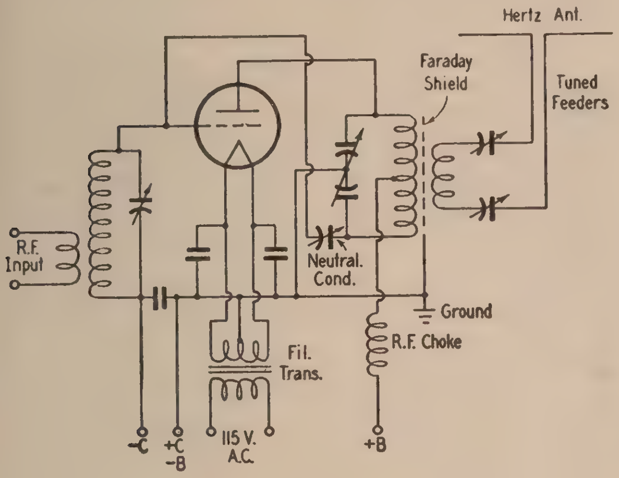
37. What is the principal purpose of using door interlock switches on a transmitter?

Door interlock switches are used on a transmitter to prevent the operating personnel from accidentally being shocked by dangerous high voltages.

38. What is the usual means for protecting amateur station equipment from damage by charges of atmospheric electricity on the antenna system?

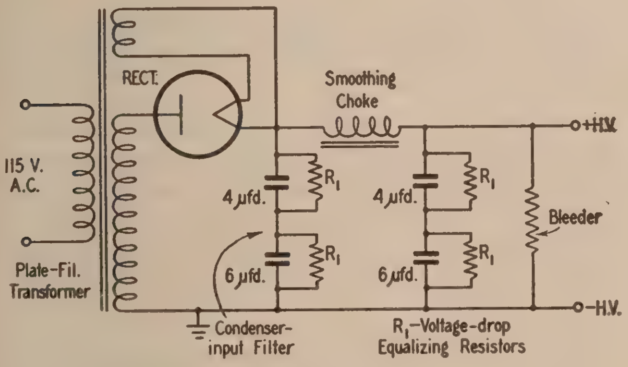
The usual means for protecting amateur station equipment is an antenna grounding switch.

39. Draw a simple schematic diagram of a plate-neutralized final r.f. stage using a triode tube coupled to a Hertzian antenna, showing the antenna system and a Faraday screen to reduce harmonic radiation.



(Q 39)

40. Draw a simple schematic diagram of a half-wave rectifier with a filter which will furnish pure d.c. at highest voltage output, showing filter condensers of unequal capacitance connected in series, with provision for equalizing the d.c. drop across the different condensers.

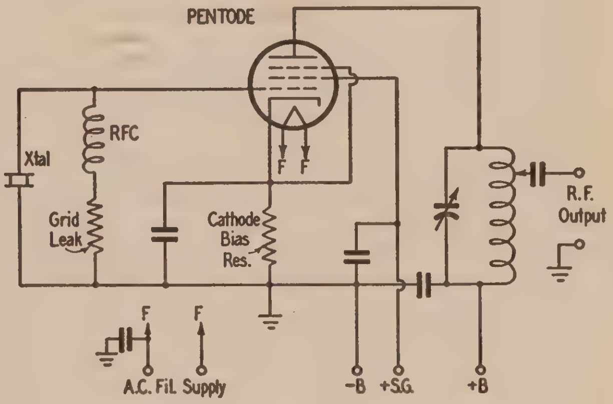


(Q 40)

41. What is a safe procedure for removing an unconscious person from contact with a high-voltage circuit?

The safe procedure is first to open the main switch of the high-voltage power supply and then remove the victim from contact with the high-voltage circuit. No direct contact should be made with any part of the victim's body until the high-voltage switch has been opened.

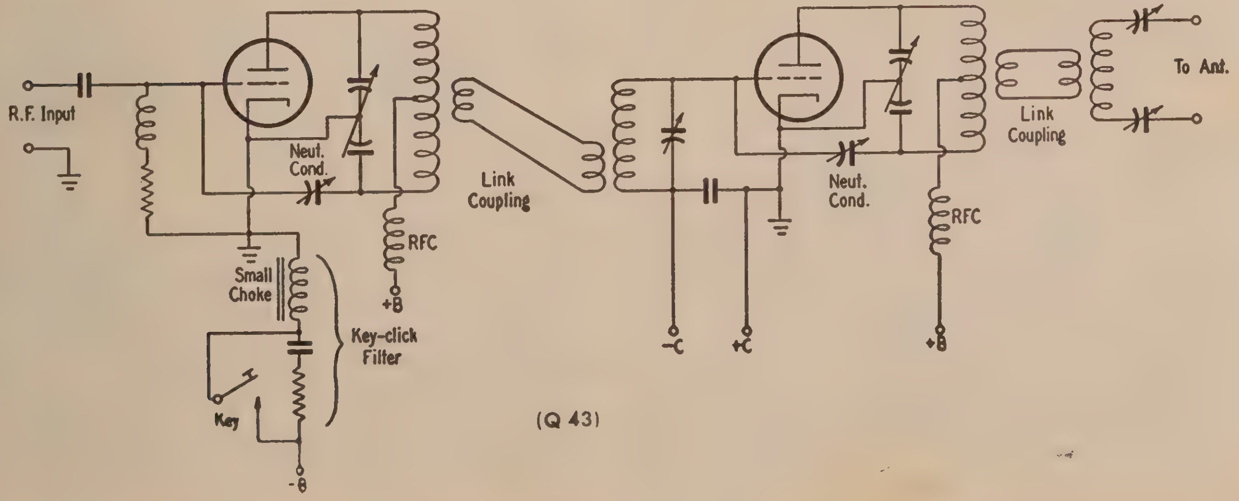
42. Draw a simple schematic diagram of a piezoelectric crystal-controlled oscillator using a pentode vacuum tube, indicating polarity of electrode supply voltages where externally connected.



(Q 42)

Note: The circuit for a tetrode (four-element) tube would be the same except that the suppressor grid would be omitted. For a triode oscillator, both the suppressor and screen grid would be omitted, as would also be the screen-grid supply-voltage terminal indicated on this pentode diagram.

43. Draw a simple schematic diagram of two r.f. amplifier stages using triode tubes, showing the neutralizing circuits, link coupling between stages and between output and antenna system, and a keying connection in the negative high-voltage lead including a key-click filter.



(Q 43)

44. Using a frequency meter with a possible error of 0.75%, on what whole-number kilocycle frequency nearest the high-frequency end of the 3500–4000-kc amateur band could a transmitter safely be set?

The frequency is 3970 kc.

Note: The formula for precise calculation of the frequency indicated by the meter is

$$f_x = \frac{f_U}{1+n}$$

where f_x is the indicated frequency
f_U is the upper band-limit frequency
n is the specified percentage error, expressed as a decimal.

In this case,

$$f_x = \frac{4000}{1.0075} = 3970.2 \text{ kc.}$$

45. Using a frequency meter with a possible error of 0.75%, on what whole-number kilocycle frequency nearest the low-frequency end of the 7000–7300-kc. amateur band could a transmitter safely be set?

The frequency is 7053 kc.

Note: The formula for precise calculation of the frequency indicated by the meter is

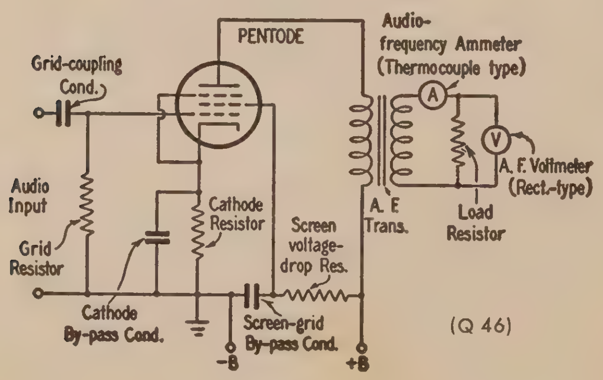
$$f_x = \frac{f_L}{1-n}$$

where f_x is the frequency indicated by the meter
f_L is the lower-limit frequency of the band
n is the specified percentage error, expressed as a decimal.

In this case,

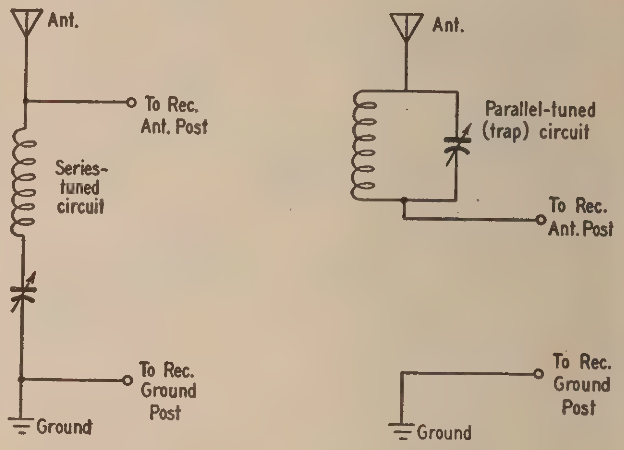
$$f_x = \frac{7000}{1-0.0075} = \frac{7000}{0.9925} = 7052.9 \text{ kc.}$$

46. Draw a schematic diagram of a pentode audio power-amplifier stage with an output coupling transformer and load resistor, showing suitable instruments connected in the secondary for measurement of the audio-frequency voltage and current, and naming each component part.



(Q 46)

47. Draw a schematic diagram of a filter for reducing amateur interference to broadcast reception consisting of (1) a series-tuned circuit connected in shunt with the b.c. receiver input to by-pass the interfering signal and (2) a parallel-tuned (trap) circuit in series with the receiver input to reject the interfering signal.



(Q 47)

48. What radio messages have priority over all other communications?

Distress calls and distress communications have absolute priority over all other communications. Communications Act, Sec. 321(b).

49. What is the penalty for willful or malicious interference with other radio communications?

A fine of up to $500 for each day during which the offense occurs, and suspension of operator license. However, if the willful interference is to distress communications, there may be added a fine of up to $10,000 or imprisonment up to two years, or both, and revocation of station license.

50. What is the FCC rule regarding emission of unmodulated carriers by amateur stations?

Emission of an unmodulated carrier, Type A0 emission, is authorized for brief tests and adjustments, for permissible remote control purposes and for experimental purposes, but is otherwise prohibited except in the band 26.96 to 27.23 Mc. and on amateur bands above 144 Mc. [§12.111 and §12.134]

51. On what amateur bands is portable operation permitted without prior notification to the inspector of the district in which such operation is contemplated?

On all bands when the over-all period that the station will be located away from the fixed location is to be less than 48 hours. [§12.91(a)]

52. When may third-party messages be handled between amateur stations of different countries?

Third-party messages may be handled between amateur stations of different countries only when such exchange has been authorized by special agreement between the countries concerned.

53. What period of each hour shall be used for making important initial calls when a state of communication emergency has been proclaimed by the FCC?

Important initial calls may be made at any time [§12.156]

54. When does a state of emergency affecting amateur communications become effective and when is it terminated?

When so ordered by FCC. [§12.156]

55. What amateur bands are affected and what frequencies are reserved for emergency calling when a state of communications emergency has been proclaimed by FCC?

Amateurs should read and be familiar with all the provisions of the emergency regulation, §12.156. Amateur bands or band segments affected would be those so designated by the Federal Communications Commission. When an emergency has been proclaimed by FCC, designated bands or segments may be used *only* for emergency communications, and all incidental calling, testing and casual conversation are prohibited.

56. On what frequencies may a licensee holding Class B (General Class) amateur privileges operate an amateur radiotelephone station?

As the holder of a General Class license is entitled to all amateur privileges [§12.23], he may use voice operation in any amateur band where such emission is permitted. [§12.111]

57. What is the FCC regulation regarding transmission of music by an amateur radiotelephone station for testing purposes?

It is prohibited. [§12.104]

58. What is the highest modulation percentage of an amateur radiotelephone transmitter permitted by FCC regulations and under what condition may it be employed?

One hundred per cent modulation is the highest permitted, and then only when means have been employed to insure that this percentage is not in excess of the modulation capabilities of the transmitter. [§12.133]

59. What power input should an amateur station use for a particular communication when the maximum legal input is 1 kw.?

The minimum input necessary to maintain the desired communication. [Communications Act, §324]

60. On what amateur bands is portable operation permitted only when prior notification has been given to the FCC Engineer in charge of the district in which such operation is contemplated?

Prior notification is required for operation on any amateur band when the over-all period of portable operation is, or is likely to be, in excess of 48 hours away from the fixed location. [§12.91 (a)]

61. On what amateur bands is adequately-filtered direct-current plate power supply required for operation of an amateur transmitter?

On all frequencies below 144 Mc. [§12.132]

62. On what amateur bands is adequately filtered direct current plate power supply *not* required for operation of an amateur transmitter?

On all authorized amateur frequencies above 144 Mc. [§12.132. See also list of said bands in §12.111]

63. What is the maximum permissible plate power input to the final stage of an amateur transmitter and under what circumstances may it be used?

The maximum input permitted at any time is 1 kilowatt on all bands except 1800–2000 Kc. and 420-450 Mc., where special restrictions apply [See §12.111]. But this 1 kilowatt input on the other bands may be used only when means are provided for measuring it accurately; if accurate measuring facilities are not available, the maximum permissible is 900 watts. [§12.131.]

64. How would a short-circuited turn of the coil affect the resonance frequency of a tuned circuit, and why?

A short-circuited turn would increase the resonance frequency of the tuned circuit because the inductance would be reduced.

65. What is meant by the harmonic of a fundamental frequency?

The harmonic of a fundamental frequency is a frequency which is an integral multiple (2, 3, etc., times) of the fundamental frequency, the fundamental being considered the first harmonic. A frequency twice the fundamental frequency is the second harmonic, one three times the fundamental frequency is the third harmonic, etc. For instance, the third harmonic of 4000 kc. is 3 × 4000 = 12,000 kc.

66. What operating characteristics distinguish the electron-coupled type oscillator with regard to frequency stability?

The electron-coupled type oscillator generally has better frequency stability with varying load conditions and operating voltages than other types of self-controlled oscillators, although it is not so stable under all conditions as a crystal-controlled type oscillator.

67. What circuit conditions will minimize the harmonic components in the output circuit of a given radio-frequency amplifier stage?

Harmonic components will be minimized by a large capacitance-to-inductance ratio in the plate tank circuit, along with grid bias not much greater than cut-off value and the minimum excitation voltage for reasonably good efficiency.

68. Give the meanings of the following "Q" signals: QRK, QRM, QRT, QRX, QSA, QSY, QSZ.

QRK: The readability of your signals is . . . (1 to 5).
QRM: I am being interfered with.
QRT: Stop sending.
QRX: I will call you again at . . . hours (on . . . kc.).
QSA: The strength of your signals (*or* those of . . .) is . . . (1 to 5).
QSY: Change to transmission on another frequency (*or* on . . . kc.).
QSZ: Send each word or group twice (*or* . . . times).

69. What is meant by a "doubler" stage?

A "doubler" stage is a vacuum-tube circuit in which the output circuit is tuned to twice or double the frequency of the input circuit.

70. Given d.c. input and r.f. output power, what is the efficiency of a tube?

The efficiency is determined by dividing the r.f. output power in watts by the d.c. input power in watts.

(*Example:* If the d.c. input power is 100 watts and the r.f output power is 70 watts, the efficiency is $\frac{70}{100}=0.7$, or 70%).

NOTE

With the opening of certain voice subbands to General (and Conditional) Class licensees, FCC has increased the scope of the examination material for those classes to cover more fully some of the radiotelephone aspects. The student of this chapter, therefore, should familiarize himself also with the following questions and answers, which are published on pages 43–53 in the Extra Class section of this manual: 150, 161, 183, 241, 247, 250, 256, 258, 264, and 267 (final amplifier portion only).

CHAPTER 5

The Conditional Class License—Examinations by Mail

• The Conditional Class license examination is available by mail under certain conditions of inability to travel to an examining point, or when the traveling distance is more than 75 miles. The Novice and Technician Class examinations are available only by mail, no matter where the applicant lives. This chapter details the procedure to be followed in obtaining amateur licenses by mail examination.

As outlined in Chapter 1, the Federal Communications Commission has an extensive field organization of district offices at which examinations for amateur licenses are given regularly. Moreover, traveling examiners visit many additional cities from one to four times each year to conduct examinations for operator licenses. However thorough this arrangement, it still leaves many portions of the country at a considerable distance from such points of examination. Especially in the case of amateur operators, who have no pecuniary interest in radio, the requirement of extensive travel would work a considerable hardship. Therefore the Commission has made arrangements whereby, under certain conditions, applicants for amateur licenses may take the examination by mail. This chapter will detail the conditions and the procedures.

The "standard" amateur license is the General Class, personal appearance for examination being required. However, the Commission also makes the same privileges available through a mail examination, in which case the license is known as Conditional Class, when the applicant:

a) lives more than 75 miles airline from the nearest city at which FCC conducts examinations four times yearly, or oftener, and proposes to set up his amateur station at his residence or some other point similarly outside such a 75-mile radius; or

b) is unable to appear for examination because of physical disability, and his inability to travel is substantiated by a physician's certificate; or

c) is unable to appear for examination because of military service, and so certified by his commanding officer.

These examinations by mail are also available to applicants in Alaska outside Juneau or Anchorage, in the Virgin Islands, and in Hawaii outside Oahu.

Examinations for Novice and Technician Class licenses are now available *only* through the mail procedure, no matter where the applicant lives.

Examination Procedure

So if you are applying for a Conditional Class license under one of the conditions listed above, or are applying for a Novice or Technician Class license, write the FCC Engineer-in-Charge of the district in which you live (see list on page 6). Tell him in what class of license you are interested, and ask for an amateur operator and station application blank and for the mail examination papers for that class. He will send you the application form, and a sealed envelope containing a set of examination questions, and detailed instructions as to procedure. *Before doing anything else read the instructions carefully.* It is extremely important that you follow each step closely.

Now, as part of the examination you have to have yourself examined in code speed by some licensed operator with whom you have made an arrangement to that effect. He must either be the holder of a General, Advanced or Amateur Extra Class license or must have held within five years a license as a commercial radiotelegraph operator or must have been employed within five years as a radiotelegraph operator in the service of the United States. See §12.44. You will also have to provide yourself with a witness who will open the envelope of questions and certify that you wrote out the answers without assistance. This may be the same person who gives you your code test, or someone else, but that person must be at least 21 years of age. If you do not know a licensed operator in your vicinity, communicate with the nearest radio club or write your ARRL Section Communications Manager (directory in front of every issue of the League's magazine *QST*), or ask the FCC Engineer to designate someone in your vicinity. You must know the name of your examiner-witness before filling out the application. There is, in fact, a specified sequence: first you fill out Form 610 (the application) which includes the data on the examiner and witness, and then you swear to it before a notary. Next you get your code examiner to give you your code test and to fill out and certify a statement of your code speed, for which a space is provided on the application form. Then, and only then, are you ready for the written examination. If you do not pass the code test, you must return the examination envelope unopened, and wait a month before trying again, during which you do some more studying. But if your code speed test was passed successfully, and the certification accomplished, your witness may *then* open the sealed examination envelope. He examines it and sees that it consists of a number of sheets of paper, bearing the examination questions. He hands these to you. You proceed to the answering of the questions. Your witness must remain constantly present, and at the conclusion sign a certification that he opened the envelope and that you wrote out the answers in his presence and without assistance from any source. There is space for this also on the application form. Then you put both the application form and the examination sheets in the envelope provided, and mail them. If you have passed, your license will come to you in a few weeks. If you have failed (you will be notified but will not be told on what questions you failed) don't be too discouraged — study some more for the examination and after another month or so try it again.

If, after failing either the code test or the written examination, a mail applicant for Conditional Class is willing to take his chances on personal examination before an Engineer, he does not have to wait thirty days from the time of his failure but can go up for the General Class examination as soon as he wants to — even the next day.

The written examinations, as well as the code test, are identical with those which would be taken for the particular class of license if you made a personal appearance. Therefore the study material in the other chapters of this booklet is directly applicable.

Special Conditions

Until recently there were two situations under which the holder of a Conditional Class license was required to appear at an examining point and take the General Class examination, or forfeit his license. These were:

a) When the licensee changes his address to a new location which is within 75-miles airline of one of the quarterly examining points.

b) When the Commission establishes a new quarterly examining point whose new 75-mile circle includes the Conditional Class licensee.

However, under new rules this requirement is abolished and a Conditional Class licensee, like the Novice and Technician, may move freely about without ever being concerned whether they have moved into one of the 75-mile circles, or whether FCC has established a new examining point near them.

It should be further noted that if a Conditional Class licensee under any circumstances violates the regulations or otherwise incurs the official displeasure of FCC, he may be called upon to journey to the nearest examining point, even though it be many hundreds of miles away, to be given the General Class examination or lose his ticket. This situation might arise, specifically, if the Conditional Class licensee should be cited under Sections 12.152, 12.153 and 12.154 of the amateur rules; in that case FCC might call him in for personal examination.

No credit towards higher classes of license accrues to holders of amateur tickets issued on the basis of mail examinations. For example, if a Conditional Class licensee with two years of experience should wish to apply for the Amateur Extra Class license he of course must not only appear for personal examination but must again pass the same examination elements which he has previously passed in connection with his Conditional Class license.

The Conditional Class license conveys privileges identical to those of the General Class — that is, operation on any authorized frequency band and with any authorized type of emission for such band.

The Advanced Class License

For many years it was the custom of the United States, and other countries as well, to require the demonstration of special qualifications before permitting an amateur to use voice communication in the more-heavily-populated bands at 3.8 and 14 Mc. No additional code speed was required, but the applicant had to be an amateur of the Conditional or General Class for a year and pass an examination in advanced amateur telephony. This license, formerly called "Class A," is now the Advanced Class license.

However, the Federal Communications Commission has cancelled the requirement of a special license for voice work in these bands, and there are no longer any amateur voice sub-bands restricted to holders of Advanced or Amateur Extra Class licenses. As of January 1, 1953, the Commission in effect withdrew the Advanced Class license from our structure by dropping all examinations for that class.

• The Advanced Class license is no longer available to new applicants. However, holders of Advanced Class licenses may renew them so long as they can comply with renewal requirements.

Current holders of the Advanced Class license will be able to renew in the usual fashion, provided they meet the specified requirements (see Chapter 1). No special operating privileges are any longer attached to this grade license, however.

The study material formerly associated with the Advanced Class license (Examination Element 4A), has now been embodied in that published for the Amateur Extra Class license.

CHAPTER 7

The Amateur Extra Class License

• The Amateur Extra Class license requires the demonstration of a considerable degree of proficiency both in code and technical fields. This chapter gives details on the top grade of amateur license and contains material which constitutes a complete study guide for the written examination.

A new "super-class" of amateur license has been established known as the Amateur Extra Class license.

No additional privileges are attached to the new license, over and above those available to regular licensees.

The requirements for the Amateur Extra Class license are:

a) two years of holding an amateur license of any class except Novice or Technician. This license-holding must have been since 1934 — i.e., issued by the Federal Communications Commission and not its predecessors.

b) passing a code test in sending and receiving at the rate of 20 words per minute.

c) passing the standard written examination in theory and regulations (credit will of course be given to holders of General and Advanced Class licenses for this requirement, as well as to holders of Technician Class licenses not issued on the basis of a mail examination.)

d) passing a new written examination dealing with advanced amateur techniques: "advanced radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony, radiotelegraphy, and transmissions of energy for measurements and observations applied to propagation, for the radio control of remote objects and for similar experimental purposes."

The Amateur Extra Class examination must be taken in person at one of the FCC examining points, either at an FCC district office or at one of the numerous cities visited by traveling inspectors according to a prearranged schedule.

However, there is a waiver of all the requirements for an Amateur Extra Class license if an applicant holds or can qualify for a General Class license or higher, and if he can submit evidence of having held amateur license prior to May, 1917. Application for the license under this arrangement is made on the usual Form 610, submitted to the FCC district office together with your present license and required evidence of license-holding prior to May, 1917, in the form of a photostat of an original license or a citation of a listing in a Government call book of that time.

In this connection, if the applicant is not listed in early government callbooks and station lists available to FCC, the following are types of evidence which may then be submitted in support of the application:

1) License documents or certified copies thereof.

2) An official letter or letters from a Department of United States Government in which reference is made to the applicant's amateur license in sufficient detail to establish that such license was actually issued to the applicant.

3) Copies of personal correspondence or of a publication, written or published prior to January 1, 1919, which refers to the applicant's amateur license and describes it in sufficient detail to establish that it was issued prior to April, 1917. Such correspondence or printed article to be fully identified and explained in a notarized statement by the applicant.

4) A statement by the applicant, under oath, that none of the foregoing data is available and in which he gives the date when his amateur license was issued, place where he resided at the time, and states how long he held such a license. In cases where only an amateur operator license is alleged such statement should describe the amateur station operated and give the name of the licensee, location of the station, and call sign. Such statement of the applicant should be supported by statements, under oath or affirmation, of at least two disinterested persons (of whom one may be a member of the applicant's family), who state that they personally knew the applicant during the time he held an amateur operator or station license issued prior to April, 1917, give details as to the relationship of the affiant to the applicant, dates and circumstances under which he held the license, and, if possible, give the call sign of the amateur station he operated.

In addition to the foregoing, the Commission will consider, for the purpose of qualification for the Amateur Extra class operator license, a Certificate of Skill issued by the Department of Commerce and Labor of the United States prior to June 30, 1913. In addition to the original or certified copy of such Certificate of Skill, the applicant must furnish proof that he actually owned or operated an amateur radio station prior to June 30, 1913. The following are illustrations of the types of evidence which may be submitted toward this end:

(1) Copies of personal correspondence or of a publication, written or published prior to June 30, 1915, which refers to the applicant's amateur operation or amateur station in sufficient detail to establish that such ownership or operation was prior to June 30, 1913. Such correspondence or printed article should be fully identified and explained in a notarized statement by the applicant.

(2) A statement by the applicant, under oath, describing the station operated, including the location, call sign

> used, and stating the name of the owner (if not the applicant) and the period of time during which the station was operated by the applicant. Such statement of the applicant should be supported by statements, under oath or affirmation, of at least two disinterested persons (of whom one may be a member of the applicant's family), who state that they personally knew the applicant during the time prior to June 30, 1913, when he owned or operated an amateur station, give details as to the relationship of the affiant to the applicant, and show related dates and circumstances under which the applicant owned or operated the amateur station.

Amateur Extra Class privileges are granted by the usual endorsement on the regular license card. In addition, holders of the top grade license are issued a special diploma-type certificate.

The 20 w.p.m. code test consists of plain language, often tricky and containing occasional punctuation such as the comma, period, diagonal and question mark. The written examination consists of about 100 questions mostly on technical subjects but including several on regulations, and with numerous diagrams required. The questions are for the most part in the usual multiple-choice form.

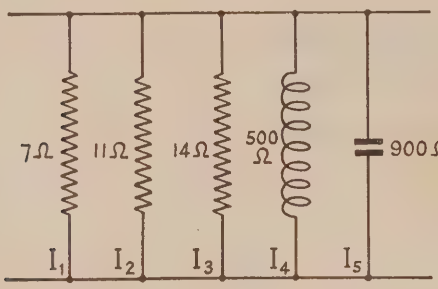
The Federal Communications Commission has issued a study guide for the written examination consisting of 279 example questions. These questions appear on the following pages, together with answers. It should again be emphasized that these are not necessarily the questions which appear on the actual examination, but are intended primarily to show the scope of knowledge required. In any event, persons intending to apply for the Amateur Extra Class license should use the material to follow in conjunction with thorough study of a standard text on radio such as *The Radio Amateur's Handbook.*

QUESTIONS AND ANSWERS FOR THE AMATEUR EXTRA CLASS LICENSE START ON THE FOLLOWING PAGE

Questions and Answers Covering Examination Element 4 (B) -- Advanced Amateur Technique

1. A parallel a.c. circuit is made up of five branches; three of the branches being pure resistances of 7, 11 and 14 ohms, respectively. The fourth branch has an inductive reactance value of 500 ohms. The fifth branch has a capacitance reactance of 900 ohms. What is the total impedance of this network? If a voltage is impressed across this parallel network, which branch will dissipate the greatest amount of heat?

The impedance of the network is 3.28 ohms. The branch consisting of the 7-ohm resistor would dissipate the greatest amount of heat since as the lowest resistance it would carry the greatest current.



(The circuit is shown in the accompanying figure. Since all the elements are in parallel, the same voltage will be applied to each. Assume 100 volts applied. Then the currents are as follows:

$$\begin{aligned} I_1 &= 100/7 &&= 14.29 \text{ amp.} \\ I_2 &= 100/11 &&= 9.09 \text{ amp.} \\ I_3 &= 100/14 &&= 7.14 \text{ amp.} \\ I_4 &= 100/500 &&= 0.2 \text{ amp.} \\ I_5 &= 100/900 &&= 0.11 \text{ amp.} \end{aligned}$$

I_1, I_2 and I_3 are in phase and may be added directly; the sum is 30.52 amp. I_4 and I_5 are out of phase and so the total reactive current is their difference, or 0.09 amp. The total reactive current combines with the total resistive current by the right-angled triangle rule, so

$$\begin{aligned} I &= \sqrt{I_R^2 + I_X^2} \\ &= \sqrt{(30.52)^2 + (0.09)^2} = \sqrt{931.5 + 0.0081} \\ &= \sqrt{931.5} = 30.52 \text{ amp., with negligible error.} \end{aligned}$$

The impedance of the circuit is then

$$\begin{aligned} Z &= \frac{E}{I} = \frac{100}{30.52} \\ &= 3.28 \text{ ohms.} \end{aligned}$$

This is essentially the parallel resistance of the three resistors alone. In a case like this it can be determined by inspection that the coil and condenser have negligible effect on the total impedance because their values are so high in comparison with the total resistance of the circuit.)

2. What is the total reactance of two inductances connected in series with zero mutual inductance?

The sum of the reactances of the two inductances.

3. When two coils, of equal inductance, are connected in series, with unity coefficient of coupling and their fields in phase, what is the total inductance of the two coils?

Four times the inductance of either.

(From the formula $L + L_2 \pm 2M$, where L is the inductance of the coils and $M = k\sqrt{L_1 L_2}$, k being the coefficient of coupling. With unity coefficient, M equals L, so the total inductance would be, since individual inductances are identical in value, $L + L + 2L$ or $4L$.)

4. What factors determine the core losses in a transformer?

Core losses are of two types, hysteresis losses and eddy-current losses. Hysteresis losses vary with the type and volume of iron or steel used in the core and with the operating frequency and magnetic flux density. Eddy-current losses vary with the volume and resistance of the core material, the thickness of the laminations, the frequency and the flux density.

5. What circuit constants determine the "copper" losses of a transformer?

Copper losses in a transformer depend on the resistances of the windings and the currents flowing in them. An external circuit affects copper losses by determining the amount of current that flows in the windings. In the transformer itself, the resistance of a winding depends on the material, usually copper, its temperature, size of wire and its total length, which in turn is determined by the number of turns and length per turn.

6. What factor(s) determines the ratio of impedances which a given transformer can match?

The ratio of impedances that a transformer can match is determined by the turns ratio, and varies as the square of the turns ratio in cases where transformer losses are small enough to be neglected. It is also assumed, in using this relationship, that leakage reactances of the transformer are very small compared with the load and source impedances, and that the reactance of each winding open-circuited is very large compared with the impedances being matched.

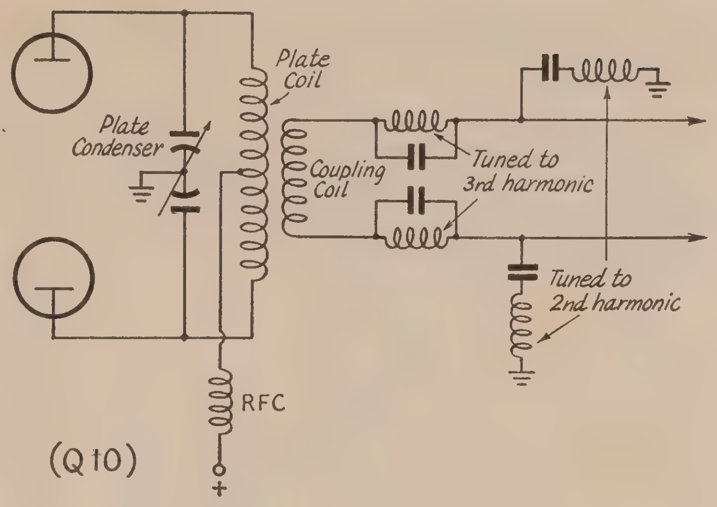
7. In a Class C r.f. amplifier, what ratio of load impedance to dynamic plate impedance will give the greatest plate efficiency?

The highest possible load impedance will give the greatest plate efficiency, since the ratio of power in the load to power lost in the plate becomes larger as the ratio of load impedance to dynamic plate impedance is increased. However, under these conditions the power output is relatively small.

8. Why should impedances be matched in speech-input equipment?
To prevent distortion and to give maximum energy transfer.

9. Why are electrostatic shields used between windings in coupling transformers?
To reduce or eliminate capacity effects between the windings.

10. Draw a simple schematic diagram showing a method of coupling the r.f. output of the final power amplifier stage of a transmitter to a two-wire transmission line, with a method of suppression of second- and third-harmonic energy.



(Q 10)

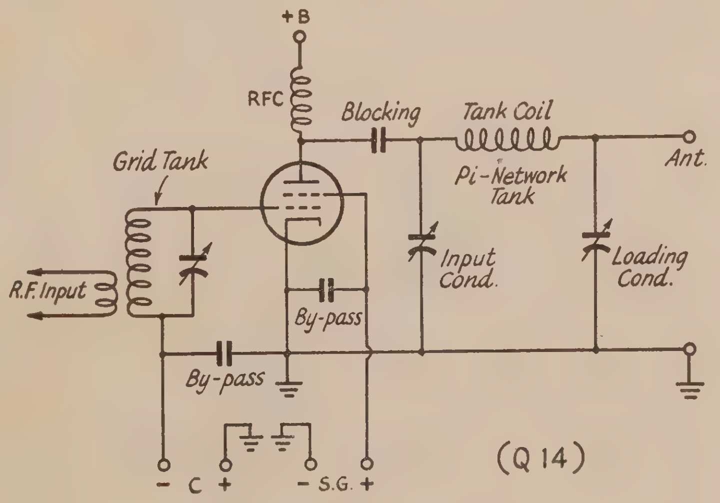
11. If the power output of a modulator is decreased from 500 watts to 10 watts, how is the power decrease expressed in db.?
— 17 db.

(See Q. 48. Substituting the above values in the formula gives db. = 10 log 50. From a table of logarithms it is found that log 50 = 1.7. Since the power has decreased, the logarithm is negative, so 10 × (— 1.7) = — 17 db.)

12. During 100 per cent sinusoidal amplitude modulation, what percentage of the average output power is in the sidebands?
33⅓ per cent. The average power output would increase 50 per cent with such modulation; i.e., a 100-watt unmodulated carrier output would rise to 150 watts. Sidebands carry the excess of 50 watts, which is one-third the total.

13. Why is it preferable to isolate the direct current from the primary winding of an audio transformer working out of a single vacuum tube?
The low-frequency response of the circuit is improved, since the elimination of d.c. current flow through the primary prevents a reduction in primary inductance below its no-current value.

14. Draw a schematic diagram of a final amplifier with capacity coupling to the antenna which will discriminate against the transfer of harmonics.



(Q 14)

15. Identify by name the treaty and article thereof which specifies the conditions under which amateur stations may be used to handle international "third party" traffic.
Article 42 of the Final Acts of the International Telecommunication and Radio Conferences, Atlantic City, 1947. (See page 62.)

16. When narrow-band frequency or phase modulation is used in the band 14,200–14,250 kc. what special conditions must be observed?

The bandwidth of the modulated carrier may not exceed the bandwidth occupied by an amplitude-modulated carrier of the same audio characteristics, and the purity and stability of such emissions must be maintained in accordance with the requirements of §12.133 of the amateur rules.

17. Do the amateur rules permit the holder of a Novice Class amateur license to operate an amateur station licensed to the holder of an Amateur Extra Class license? If the Novice Class license may operate the station, to what extent may he do so under the rules?
Yes, provided the station is operated under rules applicable to the Novice — i.e., within the frequency bands and with a type of emission available for Novice operation, crystal control in the transmitter, and not more than 75 watts input to the final stage.

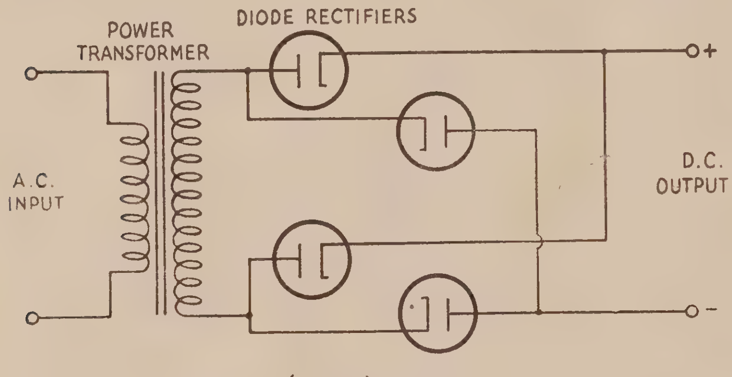
18. What is the ratio between the currents at the opposite ends of a transmission line, ¼ wavelength long and terminated in an impedance equal to its surge impedance?
The currents are equal; that is, the ratio is 1:1.

19. What is the primary reason for terminating a transmission line in an impedance equal to the characteristic impedance of the line?

In order to keep the standing-wave ratio at a minimum, thereby reducing losses on the line.

20. What is the procedure to be followed in order to determine whether Commission approval is necessary before erecting a new antenna for use at an amateur station or increasing the height of an antenna already in use at an amateur station?

Examine §12.60 of the amateur rules, which provides that Commission approval is necessary in cases where the antenna will exceed an over-all height of 170 feet above ground, or will exceed an over-all height of one foot above the established elevation of any landing area (airport) for each 200 feet or distance from the nearest boundary of the landing area. Antennas not more than 20 feet above the ground or existing structures or natural formations do not require approval, however.



(Q 22)

21. If an r.f. amplifier circuit consists of two identical tubes, the grids connected in push-pull and the plates connected in parallel, what relationship will hold between the input and output frequencies?

The output frequency will be an even harmonic of the input frequency. The plate tank circuit usually is tuned to the second harmonic (push-push doubler).

22. Draw a diagram of a bridge rectifier giving full-wave rectification without a center-tapped transformer. Indicate polarity of output terminals.

23. Draw a diagram of a rectifier system supplying two plate voltages, one approximately twice the other and using one high-voltage transformer with a single center-tapped secondary, and such filament transformers as may be necessary.

24. What is meant by "arc-back" or "flash-back" in a rectifier tube?

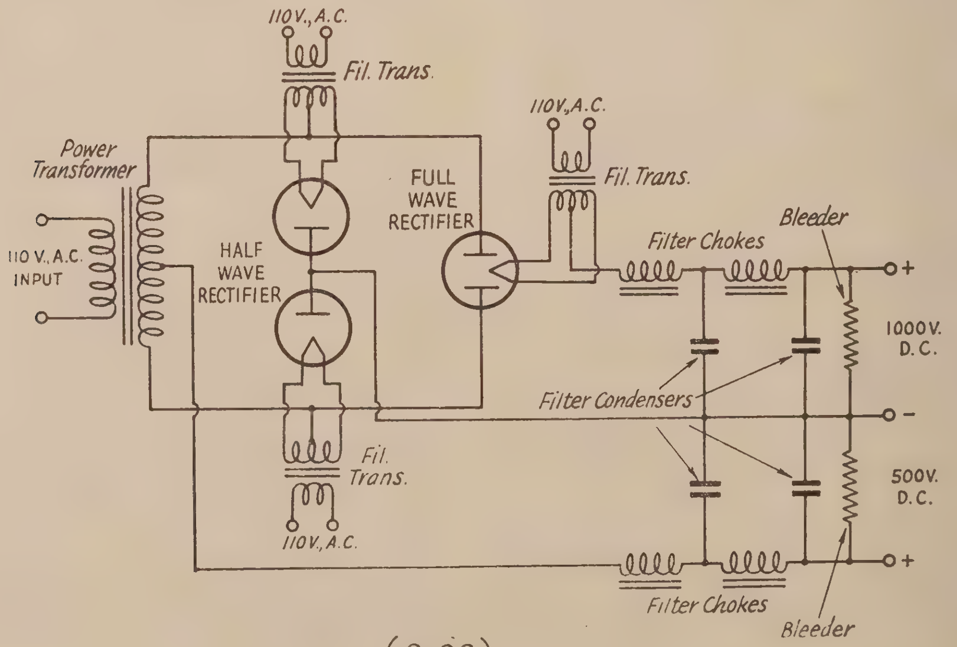
"Arc-back" or "flash-back" occurs in mercury-vapor rectifier tubes when the maximum inverse peak voltage is exceeded to the extent that a flash-over takes place between the rectifier elements in the tube and allows current to flow in the wrong direction.

25. What are synchronizing pulses as used in television transmitters and receivers?

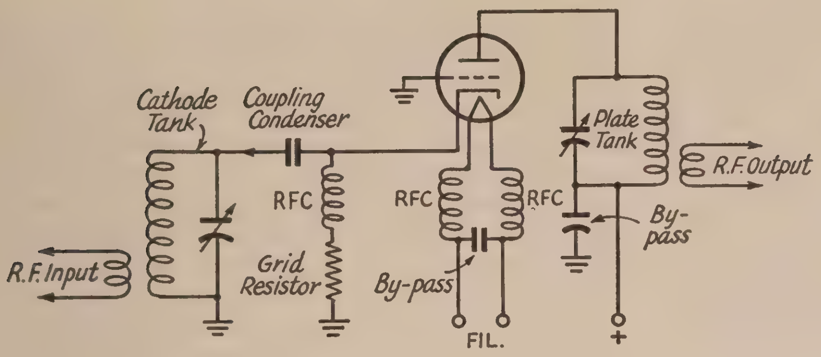
Synchronizing pulses used in television transmitters and receivers are pulses of extremely short duration which ensure that trace lines across the face of the picture tube in the receiver are synchronized or locked in with the trace lines in the television camera.

26. If an amateur frequency-modulation radiotelephone transmitter operates at 100 per cent modulation, what is the ratio of unmodulated power output to modulated power output?

1:1 — that is, no change. The power output of a frequency-modulated transmitter is not varied; only the frequency changes with modulation.



(Q 23)



(Q 27)

27. Draw a diagram of a grounded-grid amplifier.

28. What is a Doherty amplifier?

A Doherty amplifier is a linear r.f. power amplifier in which the load is divided between two tubes in such a way that the average plate efficiency is high either with or without modulation. One tube delivers the carrier when there is no modulation, the other tube being idle. With modulation, the "carrier" tube is modulated downward and also contributes part of the additional power output on the modulation up-peaks. The second tube operates essentially only on the modulation up-swing, its power being added to the output of the first during this part of the modulation cycle. The proper division of the output from the tubes is accomplished by proper choice of bias and operating conditions, and by use of circuits that automatically vary the plate loading on the two tubes in accordance with the modulation cycle.

29. What may be the cause of a decrease in antenna current during modulation of a Class B r.f. amplifier?

This is the result of nonlinear operation which may be due to any of the following: insufficient grid bias, excessive excitation, low filament emission, plate loading too light (plate efficiency under unmodulated carrier conditions too high), excessive resistance in bias supply, poor regulation of r.f. driving voltage (inadequate driver output, or insufficient "swamping" of driver output), nonlinear modulation in the earlier modulated stage or preceding Class B amplifiers.

30. How may the output voltage of a dynamotor be regulated?

By varying the input voltage in some manner such as use of a rheostat in series with the input, or tapping the input connections across a different number of battery cells.

31. What is the principal advantage in the use of a dynamotor, rather than a motor generator, to furnish plate power to a small mobile transmitter?

The dynamotor is smaller and operates at somewhat higher efficiency because of reduced mechanical losses as compared with separate machines.

32. Is a high degree of modulation desirable in connection with a self-excited type of transmitter? Explain.

No. Any reasonable percentage of modulation will, naturally, result in wide variations of plate voltage which in turn will cause variations in the transmitted frequency.

33. Describe briefly the construction of a wave guide. Why should the interior of the wave guide be clean, smooth and dry?

The most common type of wave guide is essentially a hollow metallic pipe, usually rectangular in cross-section. Its cross-sectional dimensions determine the lowest frequency that will be propagated without excessive attenuation. The interior of the wave guide should be clean, smooth and dry to minimize r.f. losses; any irregularity or discontinuity causes reflections resulting in standing waves.

34. What determines the operating frequency of a magnetron oscillator?

Its dimensions and the electric and magnetic field intensities; also, the associated circuit constants.

35. What determines the operating frequency of a klystron?

The electrode voltages and the dimensions of the associated resonant cavities.

36. In what radio circuits do klystron oscillators find application?

As local oscillators in microwave receivers and as generators of c.w. power in microwave transmitters.

37. In what radio circuits do magnetron oscillators find application?

Principally as pulsed microwave generators in radar transmitters, although magnetrons have been developed for generating relatively small amounts of c.w. power in the microwave range.

38. The Commission's rules state that the operating frequency of all radio stations will be determined by comparison with a primary standard of frequency. What is this primary standard of frequency? How is it made available for use by licensees of amateur radio stations?

The primary standard of frequency is that at the National Bureau of Standards in Washington, D. C., and it is made available for use through WWV radio transmissions on "standard" frequencies of 2,500, 5,000, 10,000, etc., kilocycles.

39. Explain how you would go about checking for spurious sidebands.

A superhet receiver having a crystal filter can be used for checking spurious sidebands outside the normal communication channel. With r.f. input to the receiver kept at a low value and with the crystal filter in its sharpest position and with b.f.o. on, tune each side of the carrier while another person talks into the microphone. Spurious sidebands will be observed as intermittent beat notes coinciding with voice peaks, or as clicks or crackles well away from the carrier frequency.

40. Why are crystals having fundamental frequencies above 5000 kc generally BT-cut rather than AT-cut?

BT-cut crystals are thicker for the same frequency and thus less susceptible to fracture.

41. Give a simple description of the operating characteristics of a reactance modulator.

Basically, a reactance modulator is a grid-modulated r.f. amplifier with its plate connected to an oscillator tank circuit. A small amount of voltage from the oscillator tank is applied, with its phase shifted 90 degrees, to a control grid in the modulator. This causes an r.f. current to flow in the modulator plate circuit (and through the oscillator tank) which is 90 degrees out of phase with the normal tank current. The out-of-phase current can be made either to lead or lag the normal tank current, depending on the particular circuit chosen; thus the reactance modulator simulates either a capacitance or inductance connected across the tank. The inductive or capacitive effect increases with the amplitude of the r.f. plate current generated by the modulator, and can be controlled by varying the amplification. This is done at an audio rate by a form of grid modulation, so that the instantaneous frequency of the oscillator can be varied in accordance with the modulating signal.

42. How does the field strength of an amateur station vary with distance from the antenna?

The "unattenuated" field strength (i.e., the free-space field strength in the absence of factors that might cause loss of energy) decreases in inverse proportion to the distance from the antenna. In ground-wave transmission the wave loses some energy in the ground and lower atmosphere and the actual field strength therefore decreases more rapidly than is indicated by the inverse-distance law. In ionosphere transmission there is also loss of energy or "absorption" in the ionosphere, with the result that the received field intensity is less than would be expected from the total distance travelled by the wave considering only the inverse distance law. Absorption factors depend on the characteristics of the ground, atmosphere, and ionosphere, and vary with the wavelength and distance.

43. What are five of the usual steps that may be taken to reduce harmonic radiation from an amateur station when such radiation causes interference to the reception of television broadcast programs?

Typical measures are as follows:

1) Shield all r.f. circuits.

2) Filter all low-frequency and d.c. supply leads leaving the shielded enclosure, to prevent harmonic currents from being conducted outside where radiation can occur.

3) Arrange r.f. circuits and wiring to minimize harmonic generation by preventing inadvertent resonances from occurring in the TV frequency range.

4) Choose operating conditions that minimize harmonic output; for example, use of cut-off bias or less on amplifier stages where permissible, use of minimum r.f. grid drive.

5) Reduce power.

6) Install harmonic traps in final stage.

7) Install an antenna-tuning network for added selectivity and harmonic suppression.

8) Install traps, stubs, or a low-pass filter between the final stage and antenna system.

9) Use an antenna that tends not to accept power at any frequency other than the fundamental; e.g., a system that is matched to the transmission line.

10) Shift to a lower-frequency band so that the harmonics falling in the TV range are of higher order and therefore have lower amplitude.

44. Lecher wires will materially aid an amateur station licensee in determining the frequency or combination of frequencies causing interference to the reception of television programs. To what frequencies should they be calibrated?

To the frequencies of the television channels where interference is experienced, or to intermediate frequencies possibly in use. Lecher wires also can be used to calibrate a test oscillator or grid-dip meter covering the above range.

45. What type of voltmeter absorbs relatively low power from the circuit under test?

Any voltmeter which has a very high resistance or impedance in comparison with the circuit under measurement; e.g., a vacuum-tube voltmeter.

46. If the conductors in a two-wire r.f. transmission line are replaced by larger conductors, how is the surge impedance affected, assuming no change in the center-to-center spacing of the conductor?

The surge impedance is lowered.

47. What may cause unsymmetrical modulation at an amateur radiotelephone transmitter?

Lack of symmetry is a common characteristic of voice waveforms, so voice modulation is practically always unsymmetrical — that is, the peak modulation percentage upward differs from the peak modulation percentage downward. The extent of such dissymmetry depends on the type of microphone and the characteristics of the speaker's voice. Unsymmetrical modulation of this type does not represent improper operation so long as the modulation system is linear. Unsymmetrical modulation due to nonlinearity may be caused by distortion in the speech equipment and modulator or by improper operation of the modulated amplifier such as, in the case of plate modulation, insufficient grid bias and r.f. excitation, incorrect plate loading, or overmodulation.

48. What is the formula for determining the db. loss or gain in a circuit?

The decibel is fundamentally based on power ratios, and is numerically equal to ten times the common logarithm of the power ratio. That is,

$$\text{db.} = 10 \log \frac{P_2}{P_1}$$

where P_1 and P_2 are the power levels at different points in the circuit. The larger of the two is generally substituted for P_2 in the formula. The logarithm is positive if there is a power gain, and negative if there is a power loss.

The formula also may be written

$$\text{db.} = 20 \log \frac{E_2}{E_1} \text{ or } 20 \log \frac{I_2}{I_1}$$

where E_2 and E_1 represent voltage levels and I_2 and I_1 current levels in the circuit. These formulas can be used only when the input and output voltages or currents are measured in identical impedances, because it is only under this condition that the proper power ratio is secured.

49. What will occur if one tube is removed from a push-pull Class A audio frequency amplifier stage?

Primarily, the power output obtainable without serious distortion will be reduced to one-half or less. Although the single tube can be operated within acceptable distortion limits, the total distortion will be somewhat greater than from the push-pull stage (even at the reduced power output) for the following reasons: Even-harmonic distortion is no longer canceled as it is in the push-pull amplifier; the output transformer will tend to saturate from the unbalanced d.c. in the primary when only one tube is operating, the grid bias may not be optimum if a cathode resistor value based on two tubes is used; and the load resistance reflected on the plate is reduced since only one-half the output transformer primary is working.

50. If an amateur station licensee receives a report indicating that his station was measured 450 cycles below the edge of a band assigned for use by amateur stations but station records show that at the specified time measurements at the station showed the frequency to be 50 cycles inside the lower edge of the band, what is the error in the device used at the station to measure the frequency?

The sum of the two measurements, or 500 cycles, if it can be assumed that the equipment used by the reporting station is 100 per cent accurate. Percentage error would be expressed as $\frac{500}{f} \times 100$, where f is the measured frequency in *cycles* per second.

51. What procedure can be used to determine whether the limiter circuit of a frequency-modulation receiver is operating properly?

If a frequency-modulated signal generator is available, the audio-frequency output of the receiver should remain constant, with constant tone modulation, when the generator output is varied, except when the signal strength is reduced to the point where noise becomes audible. A similar test can be made with an unmodulated signal generator (or by tuning in unmodulated signals off the air) by measuring the d.c. voltage developed across only one of the diode load resistors in the discriminator. The voltage should be constant, above the threshold, regardless of the input signal strength.

52. What is the maximum current that may be continuously and safely passed through a 10,000-ohm resistor rated at 25 watts without injury to the resistor?

Fifty milliamperes (0.05 ampere).

(The formula for power dissipation is $P = I^2 R$, where P is power in watts, I is current in amperes, and R is resistance in ohms. Transposing algebraically,

$I^2 = \frac{P}{R}$. Substituting, $I^2 = \frac{25}{10{,}000} = 0.0025$, and

$I = \sqrt{.0025} = 0.05$ ampere.)

53. Describe an electrodynamometer type ammeter.

The electrodynamometer ammeter has two coils, one fixed and the other (to which the pointer is attached) pivoted to rotate within the first. Current passing through the two coils in series sets up magnetic forces that cause the pivoted coil to turn an angular distance depending on the strength of the current and the construction of the coils.

54. Why is a shunt used on an ammeter?

To increase its range of measurement — i.e., to permit measurement of higher values of current.

55. What is an ion?

An ion is a minute physical particle which is electrically charged, positive or negative; for example, an atom which has lost one of its electrons or which has gained an electron.

56. Name a type of detector that requires no local source of d.c. power.

A crystal detector.

57. Describe the principal construction characteristics of a D'Arsonval type ammeter.

Principal characteristics in construction of a D'Arsonval type meter are a permanent magnet and a pivoted coil (through which the current to be measured passes, and to which the indicator is attached) placed in the field between the poles of the magnet.

58. Assuming each meter to be properly calibrated, how may the total current flowing through a circuit be determined from the readings of two ammeters connected in series in the same circuit?
Take the reading of either meter. If each meter is properly calibrated, they should show identical currents.

59. How many watts equal 10 milliwatts?
A milliwatt is one-thousandth of a watt; ten milliwatts therefore equals 0.01 watt.

60. What effect on the capacitance of a condenser would result from a change in the dielectric constant of the material between the plates of a condenser?
The value of capacitance would be changed depending upon the dielectric constant of the new material; if it were greater, the capacitance would be greater; conversely if it were lower, the capacitance would be reduced.

61. What is the lowest assigned amateur frequency band in which the transmission of television signals is permitted?
420–450 Mc.

62. If a television transmitter is being operated under the authority of an amateur station license issued to the holder of an amateur Extra Class license, may the transmitter be controlled by the holder of: A Novice Class license? A Technician Class license? A Conditional Class license?
Novice — no; Technician and Conditional — yes. Novices are not authorized to operate amateur stations above 420 Mc. (where television transmission is permitted), while Technician and Conditional Class licensees are.

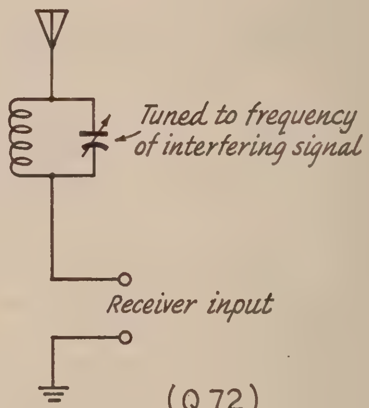
63. What is the purpose of the mosaic plate in a television camera? To what item of photographic equipment is it similar in function?
The purpose of the mosaic plate in a television camera is to store an electrical image corresponding to the visual image focussed upon it, for later scanning by an electron beam to translate the electrical image into a television signal. Its function is similar to that of the film in a photographic camera, which similarly stores the image for later development.

64. Why are synchronizing pulses transmitted with television signals?
Synchronizing pulses are transmitted to ensure that trace lines across the face of the picture tube in the receiver are synchronized or locked in with the scanning lines in the television camera.

65. Under what conditions may the holder of an Amateur Extra Class license operate an amateur station for the purpose of communicating with a ship station licensed by the Federal Communications Commission?
An Amateur Extra Class licensee may operate an amateur station for the purpose of communicating with a ship station when that station has been specifically authorized by the Commission to communicate with amateur stations.

66. It is good practice to speak across rather than into some of the older types of microphones, such as carbon button types. Why is this so?
There is less tendency toward overloading the microphone, or "blasting," and consequently the reproduction is more faithful to the original speech. Also, the possibility that moisture from the breath will enter the working parts of the microphone to cause possible difficulty is lessened.

67. Is it necessary to neutralize frequency-multiplier stages in a transmitter?
Ordinarily no, since the grid and plate circuits are usually tuned to frequencies having sufficient separation to prevent self-oscillation.



(Q 72)

68. Upon what characteristic of an electron tube does a dynatron type oscillator depend?
It depends on the fact that in some types of tubes, particularly the early forms of tetrodes, electrons striking the plate will cause "secondary" electrons to be "splashed out", and if the plate is operated at a lower positive potential than the screen the secondary electrons will be attracted to the screen. This reverse flow decreases the total plate current. Over a small range of plate voltages, increasing the plate voltage will cause the plate current to decrease, giving a "negative resistance" characteristic. By proper choice of screen and plate potentials, this apparent negative resistance can be made of sufficiently low value to maintain oscillation in a tuned circuit connected between the plate and screen. The negative resistance need only be equal to or less than the parallel impedance of the tuned circuit in order to maintain continuous oscillations.

69. What is the principal advantage in the use of a diode detector instead of a grid-leak type triode detector?

The linearity is good, and the signal-handling capability is high so that little or no overloading occurs.

70. Explain the cause and prevention of interference to radio receivers installed in automobiles.

Interference primarily arises from energy radiated by spark discharges in the ignition and electrical systems, such as spark-plug discharges, sparking at the commutator of the generator, and sparking at the points of the voltage regulator.

Prevention methods include installation of suppressors on the spark plugs and/or distributor, cleaning and adjusting spark-plug points and distributor points, condensers across the generator output, grounding all control cables leading through the fire wall, keeping ungrounded wiring short and close to grounded surfaces, and shielding of wiring likely to carry r f. energy generated by sparking.

71. On what frequencies may the holder of an Amateur Extra Class license operate an amateur station on board a ship outside of the United States, its territories or possessions?

In the amateur band 28–29.7 Mc.

72. Show by a diagram how to connect a wavetrap in the antenna circuit of a radio receiver to attenuate an interfering signal.

73. What are the properties of a series condenser, acting alone in an alternating-current circuit?

If the condenser is the only element in the circuit, the current will be proportional to the frequency and also proportional to the capacitance, assuming that the applied voltage remains constant as the frequency is varied. The current through the condenser will lead the voltage across it by 90 degrees. If a condenser is inserted in a circuit containing other elements, its effect will be to change the current and phase angle, the exact nature of the change depending on the kind and values of the other elements. So far as the condenser itself is concerned, the relationship between the current through it and the voltage across it is the same as above.

74. Is it necessary for an amateur television station to transmit all or parts of both sidebands in order to put a satisfactory video signal on the air?

No. All necessary picture information may be transmitted via the one sideband.

75. What frequency bands between 1800 and 2000 kc. are used by the Loran system of radio navigation?

The entire band between 1800 and 2000 kc. There are two 100-kc. channels, 1800–1900, and 1900–2000 kc.

76. When an amateur station is being operated on board an aircraft en route on an international voyage outside of the 10 call sign areas, how should its call sign be transmitted?

On telegraphy, with the fraction bar plus the indicator AM; in addition, the number of the aircraft and its approximate geographical location must be transmitted at the conclusion of the work. On telephony, the call sign must be preceded by the words "this is," or the word "from," followed by the words "aeronautical mobile." Again, the number and approximate geographical location must be given at the end of work.

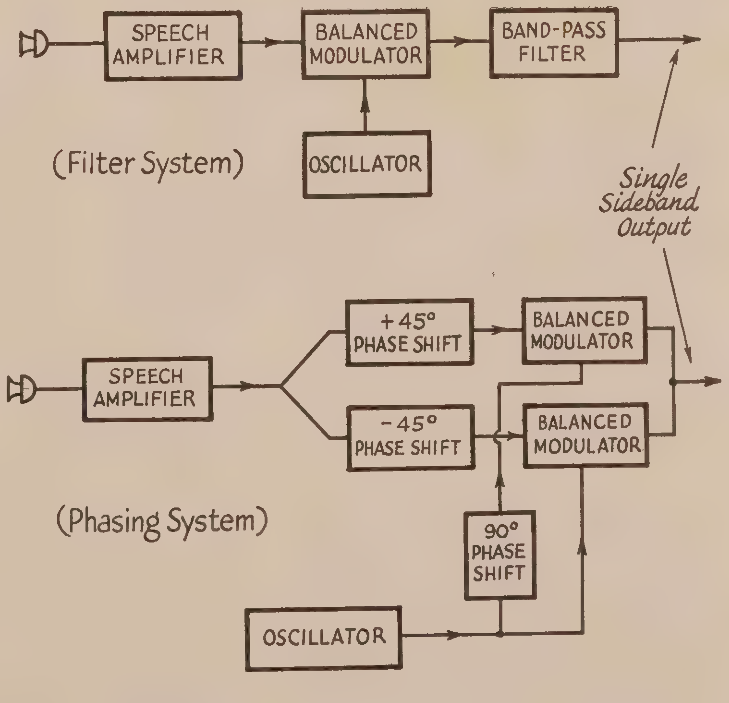
77. Describe a vacuum-tube keyer.

A vacuum-tube keyer consists of a vacuum tube whose plate and cathode are connected across the terminals to be keyed, and whose grid circuit is normally biased to cut-off so that no plate current may flow. The telegraph key is connected so as to decrease the bias sufficiently to permit full current to flow through the tube and therefore across the terminals to be keyed.

78. Draw a block diagram of a system for generating single-sideband signals.

79. What may be done to overcome instability in a tetrode amplifier which results from ineffective screen by-passing?

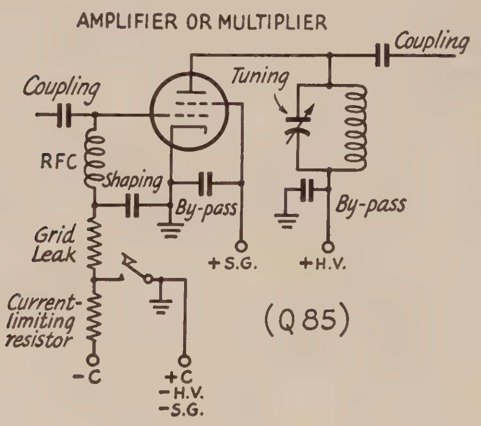
Adequately by-pass the screen.



(Q78 – TWO ALTERNATIVE METHODS ARE SHOWN)

80. What precautions should be taken before using a heterodyne type frequency meter?

Permit it to "warm up" enough to achieve temperature stability. It is also advisable to check the calibration, at least at one point, against a standard such as WWV or a stable crystal oscillator.



(Q 85)

81. What are the advantages offered by narrow-band f.m.?

Relatively simple and economical modulation circuits, modulation takes place at low level and the signal may be amplified in either Class C amplifiers or frequency multipliers without critical adjustment, the signal occupies essentially the same spectrum as an AM signal, less interference to broadcast reception from pick-up on the receiver's audio circuits (since the latter will not respond to a frequency-modulated signal) and, generally, less interference to television reception since f.m. does not usually cause "sound bars" in the picture, and the final stage of the transmitter may be operated in such a way as to have low harmonic output without affecting the linearity of modulation.

82. What frequencies have substantially straight-line propagation characteristics analogous to that of light waves and are unaffected by the ionosphere?

In the absence of any medium that can cause reflection, refraction, or diffraction, all radio frequencies have straight-line propagation characteristics. Regular propagation via the ionosphere occurs on frequencies up to about 30 Mc., but ionospheric propagation seldom occurs above 100 Mc. In the range from 30 to 100 Mc. ionospheric propagation occurs sporadically.

83. Wheel and tire static may cause objectionable interference to receivers associated with amateur mobile stations installed in automobiles. Explain methods for overcoming these types of interference.

Wheel static may be reduced by the installation of static collectors available from automobile service agencies. Tire static may be reduced by injecting an antistatic powder into the inner tubes.

84. What value of resistance should be in series with a keying relay coil designed to operate on 125 milliamperes and having a resistance of 500 ohms when it is to operate from a 110-volt d.c. source of power?

380 ohms.

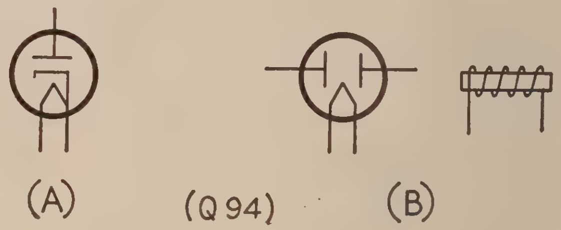
(The voltage drop across the relay coil under specified conditions would be IR, or 0.125 × 500, or 62.5 volts. The series resistor must be calculated to accommodate the remaining voltage, 47.5 (110 less 62.5). The value of this series resistor is obtained from Ohm's Law,

$$R = \frac{E}{I} \text{ or } R = \frac{47.5}{0.125}, \text{ or 380 ohms.)}$$

85. Draw a simple schematic diagram showing how a radiotelegraph transmitter may be keyed by the "grid-blocking" method.

86. What is an advantage derived from the "grid-blocking" method of keying when used with high-power amateur radiotelegraph transmitters?

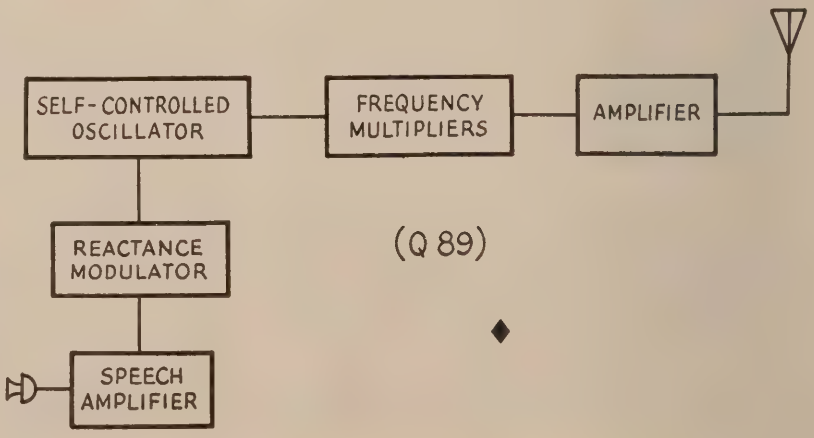
Amplifier keying may be accomplished without the problems that arise in making and breaking a circuit with considerable current flow. Also, it offers a convenient means for shaping the keying to the desired characteristic.



(Q 94)

87. List the various points in a radiotelegraph transmitter where keying can be accomplished.

Keying can be accomplished in the plate circuit (usually the negative side), the screen-grid circuit (in multi-element tubes), in the cathode circuit, or in the grid circuit — of any stage — and in the primary of the power supply.



(Q 89)

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88. What is meant by frequency-shift keying and how is it accomplished?

In frequency-shift keying the radiated power is constant, the code characters being formed by transmitting the "mark" on one frequency and the "space" on another. The two frequencies usually differ by less than 1000 cycles per second. Frequency-shift keying may be accomplished by any means, such as keying a small capacitance across a self-excited oscillator tank circuit or across a crystal, that permits changing the frequency between the two chosen values at a rate sufficient for the desired keying speed.

89. Draw a block diagram of an f.m. transmitter.

90. In transmitting video signals, what type of modulation is normally employed?

Amplitude modulation is usually employed.

91. What is the constant frequency variable dot (CFVD) system of transmitting facsimile signals?

An early, but now practically obsolete, method of transmitting facsimile in which the picture is divided into a fixed number of elements, for each of which a black dot of size proportional to the original density of the element is transmitted. The system corresponds approximately to the method used in half-tone printing.

92. What are the "Baudot" and "Seven Unit" codes? How are they used?

Both are codes used in teleprinter operation, Baudot with synchronous printers and the 7-unit teletype code with start-stop printers. Each transmitted character has assigned to it a fixed time interval divided into units, 5 in the case of Baudot and 7 in the case of the 7-unit teletype. A particular character is distinguished by a unique combination of mark and space units, the total number of units in that particular code being used in all cases.

93. In what amateur bands may frequency shift keying be used to transmit radio printer signals?

26.96–27.23, 29–29.7, 52.5–54 Mc., and higher frequency amateur bands. Effective Feb. 20, 1953, also in the non-voice portions of 80, 40 and 20 meters.

94. Draw the schematic symbols for:

(a) A simple cylindrical magnetron.

(b) A split-anode negative-resistance magnetron.

95. What is the purpose of an "ion trap" in a cathode ray tube? How does it function?

The purpose of the ion trap in a cathode-ray tube is to prevent ionized gas particles from being beamed at the fluorescent face of the tube. In magnetic-deflection tubes such particles are deflected much less than electrons, because of their much greater mass, and hence in time burn a spot ("ion spot") at the center of the screen. To prevent this, the beam is first directed at an angle to the normal line, then deflected back again to the proper path by means of permanent magnets. The ions, being heavier, continue in the original direction and fall harmlessly to one side, leaving only electrons in the beam which actually reaches the screen.

96. What is the most common effect on a received television picture of the following types of interference:

(a) Blocking or overloading of the TV receiver by the fundamental frequency of an amateur radio-telegraph signal?

(b) Beating of the picture carrier by the harmonic of an amateur amplitude-modulated radio-telephone signal?

(c) Beating of the picture carrier by the harmonic of an amateur frequency-modulated radio-telephone signal?

a) Picture turns negative or screen goes black.

b) In addition to the effects that would be produced by an unmodulated harmonic of the same frequency and intensity, horizontal bars of spacing and intensity that varies with the modulation usually will appear.

c) The cross-hatching that results from the beat between the harmonic and the picture carrier wiggles laterally with the modulation.

97. What is meant by vertical polarization of a radio wave? Horizontal polarization? How are they accomplished?

The polarization of a radio wave is, by definition, the same as the direction of the electric-field intensity. A horizontally-polarized wave is one in which the lines of electric force are horizontal; i.e., parallel to the earth. A vertically-polarized wave is one in which the lines of electric force are perpendicular to the earth's surface. With linear antennas, the polarization of the transmitted wave is the same as the antenna itself: i.e., a horizontal antenna radiates horizontally-polarized waves and a vertical antenna radiates vertically-polarized waves.

98. In designing band-pass filters what type of condensers are likely to make the most suitable capacitors?

Desirable characteristics in a condenser for this purpose are very low losses and negligible inductance. The type of condenser best suited depends on the frequency band for which the filter is designed. For audio frequencies, oil-impregnated paper condensers are suitable; at low radio frequencies silver mica condensers are appropriate; at high radio frequencies air condensers of proper design are best.

99. What are two methods used to generate a single-sideband signal?

The two systems are the band-pass filter method and the audio-phasing network method. In the band-pass filter method, the output of a low-frequency oscillator is combined with the audio output of a speech amplifier in a balanced modulator, and only the upper and lower sidebands appear in the output. One of the sidebands is passed by the filter and the other rejected, so that the output contains only the one sideband. In the audio-phasing network method, the audio signal is split into two components that are identical except for a phase difference of 90 degrees. The output of the r.f. oscillator is also split into two separate components having a 90-degree phase difference. One r.f. and one a.f. component are combined in each of two separate balanced modulators. The carrier is suppressed in the modulators, and the relative phases of the sidebands are such that one sideband is balanced out and the other accentuated in the combined output.

100. What is the function of a balanced modulator?

A balanced modulator performs the normal function of modulating a carrier wave, but in addition has provision for balancing out the carrier so that the output contains only the sidebands.

101. What class of radio-frequency amplifier must be used to amplify the signals generated in a single-sideband transmitter?

A linear amplifier, such as Class A, AB_1, AB_2, or B.

102. What would be the result of using a Class C amplifier in the output stage of a single-sideband transmitter?

Since a Class C amplifier is not a linear amplifier of the r.f. voltage applied to its grid circuit, the modulated signal would be greatly distorted. Because of this, the frequency spectrum occupied by the signal would be considerably wider than that occupied by the signal applied to the grid circuit.

103. What are the advantages of using single-sideband transmissions?

Higher useful power output for a given tube, spectrum economy, power supply economy, reduction in adjacent channel interference (heterodyne and sideband).

104. What is the percentage of efficiency of a Class B linear amplifier as used in a single-sideband transmitter as compared to the usual Class C amplifier?

The peak efficiency is approximately the same.

105. Is it always necessary to use two tubes in a Class B linear amplifier at radio frequencies?

No, because in a properly-operating Class B r.f. amplifier only the individual r.f. cycles suffer distortion, and the r.f. harmonics generated can be filtered out in the plate tank circuit. The single-tube amplifier is linear for the modulation envelope, so that the modulated wave is amplified without distortion.

106. Define a buffer amplifier.

A buffer amplifier is an intermediate stage used to raise the power level and to protect an oscillator from frequency changes which might be caused by tuning, loading or keying subsequent stages.

107. What are the advantages of a self-controlled oscillator over the crystal-controlled type?

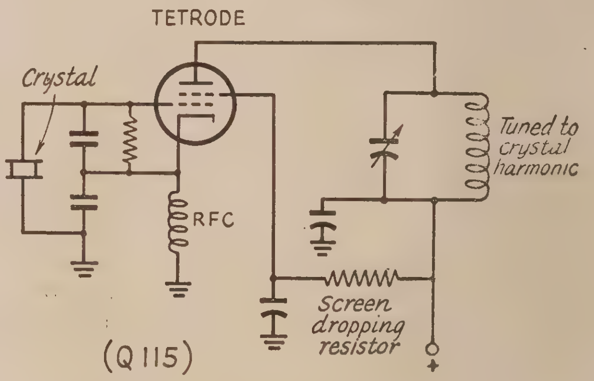
The frequency may be easily changed as desired; greater power output may be secured.

108. What are the advantages of a crystal-controlled oscillator over the self-controlled type?

It generally has better frequency stability, and operates at a known frequency.

109. Explain the principles of inductive neutralization.

Inductive neutralization consists of balancing the feed-back through the grid-plate capacitance of the tube by an equal amount of feed-back of opposite phase, obtained by connecting, between grid and plate, a coil having the same absolute value of reactance as that of the grid-plate capacitance.

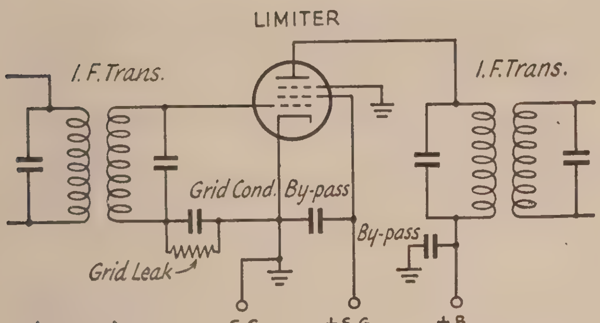


(Q 115)

110. The power output from a crystal oscillator has what effect on the radio-frequency crystal voltage?

Operating a crystal oscillator at high power output generally requires high plate voltage, which in turn means that the r.f. crystal voltage is large. Therefore, other things being equal, the higher the power output the higher the r.f. crystal voltage. However, the ratio of r.f. crystal voltage to power output will vary with different tube types and circuits, so it is possible to operate some tubes at power levels, without endangering the crystal, that would cause crystal fracture with other tubes and circuits. With a given tube, circuit, and plate voltage the r.f. crystal voltage is usually least when the load is adjusted for maximum power output, since under this condition the feed-back voltage is lower than under no-load conditions.

111. A crystal may be fractured by excessive radio-frequency voltage. What precau-



(Q 121)

tionary measures can be taken to prevent it?

Use low plate voltage; measure the crystal current (a low-current pilot light bulb may be used as a fuse in series with the crystal); do not permit the oscillator to run without a load.

112. How would you determine the safe power input to a crystal oscillator circuit?

Insert an r.f. current indicator, such as an r.f. milliammeter or a pilot lamp of suitable current rating, in series with the crystal and then gradually raise the power input until the crystal current is that specified by the manufacturer for the crystal in use.

113. How may a Tri-tet oscillator be correctly adjusted?

Assuming a tube with good screening is used, by adjusting plate-circuit tuning to resonance at the crystal frequency or a desired harmonic, and adjusting the tuned cathode circuit for optimum feed-back as evidenced by satisfactory power output with minimum crystal current. The cathode circuit will usually be tuned well above the crystal frequency (but not as high as twice the crystal frequency) under these conditions.

114. When the plate tank circuit is tuned through resonance what occurs with respect to the plate current of a crystal oscillator?

The plate current dips sharply at the resonance point, rising again as tuning continues past the point of resonance.

115. Draw a diagram of a crystal oscillator circuit in which the output will be at a harmonic of the crystal frequency.

116. The frequency at which a crystal will oscillate is the result of what factors?

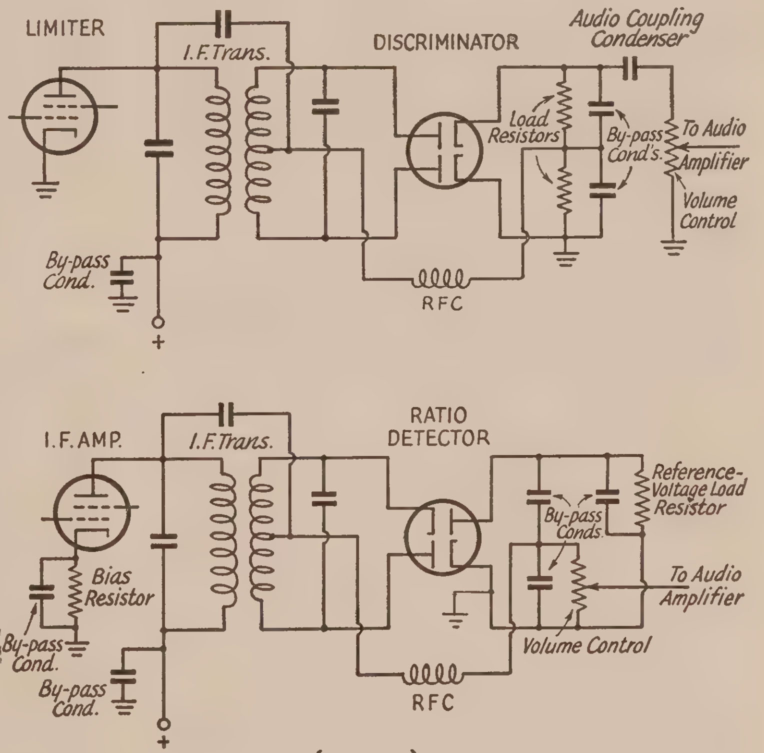
The dimensions of the crystal, its temperature, the axis of the crystal material on which it was cut, the characteristics of the holder, and the shunting capacity of the circuit.

117. What are some reasons why a crystal oscillator may fail to function?

Crystal inoperative because of fracture, or dirt in the holder; circuit constants not suitable; too heavy loading; insufficient regeneration.

118. In order to give the highest frequency stability, what requirement must be adhered to in the design of an oscillator tank circuit?

The tank circuit should have a large ratio of capacitance to inductance (high-C circuit) to reduce dynamic instability; the coil and condenser should be sturdily constructed and mounted, to avoid frequency changes caused by mechanical vibration; the construction should be such as to minimize changes in electrical constants because of temperature changes.



(Q 122)

119. What is the maximum frequency deviation permitted an amateur narrow-band frequency-modulation transmitter?

The deviation must be such that the bandwidth of the modulated carrier shall not exceed the bandwidth occupied by an amplitude-modulated carrier of the same audio characteristics.

120. What is the meaning of the term "frequency swing" in reference to frequency-modulation transmitters?

The term "frequency swing" means the peak difference between the maximum and the minimum values of the instantaneous frequency.

121. Draw a diagram of a limiter stage in a frequency-modulation receiver.

122. Draw diagrams of two types of frequency-modulation receiver detector circuits.

123. What is the purpose of a limiter stage in a frequency-modulation receiver?

To eliminate any amplitude variations in the received signal before it reaches the f.m. detector.

124. What is a ratio detector?

It is a frequency-modulation detector that is inherently insensitive to amplitude variations and thus does not require a preceding limiting stage, as do other forms of f.m. detector.

125. If a frequency-modulation transmitter employs one doubler, one tripler and one quadrupler, what is the carrier frequency swing when the oscillator frequency swing is 2 kilocycles?

48 kc. [2 kilocycles × 2 (doubler) × 3 (tripler) × 4 (quadrupler)].

126. What determines the rate of frequency swing of a frequency-modulation transmitter?

The frequency components in the modulating signal.

127. What is the purpose of a de-emphasis circuit in a frequency-modulation receiver?

To compensate for the pre-emphasis on the transmitted signal.

128. A frequency-modulation transmitter is modulated at 50 per cent by a 7000-cycle test tone. When the frequency of the test tone is changed to 5000 cycles and the percentage of modulation is unchanged, what is the transmitter frequency swing?

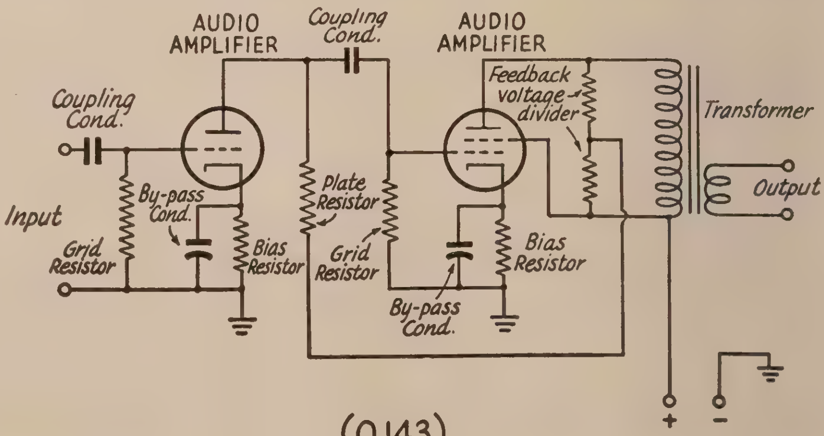
The same, since it depends on the "percentage" of modulation.

129. What is the purpose of a discriminator in a frequency-modulation receiver?

To demodulate the incoming signal.

130. Explain the properties of a quarter-wave section of a radio-frequency transmission line.

A quarter-wave line section has the property of transforming impedances. When a load of given impedance is connected to the output terminals, the input impedance of the section is equal to the square of the characteristic impedance of the section divided by the load impedance. Thus a quarter-wave line terminated in zero impedance (short-circuit at the output end) has infinite input impedance, theoretically, and a line terminated in an infinite impedance (open-circuited at the output end) has zero input impedance, theoretically, and thus represents a short-circuit.



(Q 143)

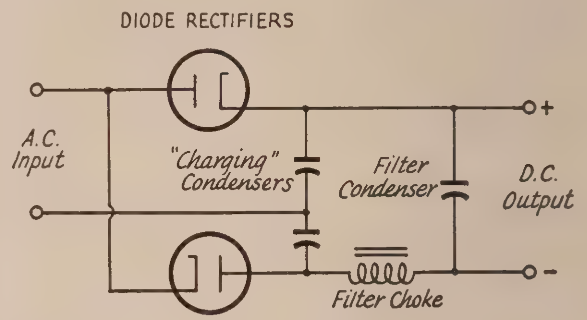
131. If the spacing of the conductors in a two-wire radio-frequency transmission line is doubled, what change takes place in the surge impedance of the line?

The surge impedance is increased by approximately 83 ohms.

(This is so regardless of the original surge impedance. The formula for surge impedance is

$$Zo = 276 \log \frac{b}{a}$$

where b is the spacing and a the radius of the conductors, both in the same units. If the spacing is doubled, the ratio b/a is doubled, so that the factor $\log b/a$ becomes $\log b/a + \log 2$. Thus doubling the spacing adds 276 log 2 ohms, or 83 ohms, to the original surge impedance.)



(Q 145)

132. What type of voltmeter is appropriate to measure peak a.c. voltages?

An oscilloscope, or certain types of vacuum-tube voltmeters.

133. What type of voltmeter absorbs no power from the circuit under test?

An electrostatic voltmeter, or a slide-back type vacuum-tube voltmeter provided there is a d.c. path through the source being measured.

134. What type of meter is suitable for measuring radio-frequency currents?

A thermocouple ammeter, "hot-wire" ammeter, or a rectifier type ammeter.

135. What type of meter is suitable for measuring peak a.c. voltages?

An oscilloscope, or certain type of vacuum-tube voltmeters.

136. What is the ohms per volt of a voltmeter constructed of a 0-1 d.c. milliam-

meter and a suitable resistor which makes the full-scale reading of the meter 500 volts?
One thousand ohms per volt.

(With any instrument, the ohms-per-volt is equal to $1/I$, where I is the full-scale current in amperes. Thus the ohms-per-volt with a 0-1 milliammeter is equal to $1/0.001 = 1000$.)

137. A current-squared meter has a scale divided into 50 equal divisions. When 45 milliamperes flow through the meter the deflection is 45 divisions. What is the current flowing through the meter when the scale deflection is 25 divisions?
33.6 milliamperes.

(The linear motion of the indicator is proportional to the square of the current flowing so,
$\frac{45^2}{45} = \frac{x^2}{25}$, or $x^2 = 45 \times 25$, $x = \sqrt{1{,}125}$, or 33.6 ma.)

138. For maximum stability, should the tuned circuit of a crystal oscillator be tuned to exact crystal frequency?
No, it should be tuned to a slightly higher frequency.

139. What material is used in shields to prevent stray magnetic fields in the vicinity of radio-frequency circuits?
Any good conducting material will serve, but the higher the conductivity the better the shielding, other things being equal.

140. What is meant by secondary emission in a vacuum tube?
The emission of electrons from an electrode due to bombardment by those from the filament or cathode.

141. What is the purpose of a screen grid in a vacuum tube?
Its principal purpose is to reduce the grid-plate capacitance and thus prevent feed-back when the tube is used as an amplifier at radio frequencies.

142. What is the meaning of "mutual conductance" and "amplification factor" in reference to vacuum tubes?
Mutual conductance is the change in plate current divided by the change in grid voltage that causes the plate-current change (the plate voltage being fixed). The amplification factor is the ratio of a plate-voltage change which causes a given plate-current change, to the grid-voltage change which causes the same plate-current change.

143. Draw a diagram of an audio amplifier using inverse feed-back.

144. What determines the fundamental operating frequency range of a multivibrator oscillator?
The time constants of the *R-C* combinations in the plate and grid circuits.

145. Draw a diagram of a voltage-doubling power supply using two half-wave rectifiers.

146. When mercury-vapor tubes are connected in parallel in a rectifier system, why are small resistors sometimes placed in series with the plate leads of the tubes?
To permit both tubes to operate simultaneously. Without such "equalizing" resistors, one tube would carry the entire current.

147. What is the predominant ripple frequency in the output of a single-phase full-wave rectifier when the primary source of power is 110 volts at 60 cycles?
120 cycles.

148. What does the term "power factor" mean in reference to electric power circuits?
It is the ratio of power actually consumed to that which would be computed by multiplying the voltage by the current.

149. A potential of 110 volts is applied to a series circuit containing an inductive reactance of 25 ohms, a capacitive reactance of 10 ohms and a resistance of 15 ohms. What is the phase relationship between the applied voltage and the current flowing in this circuit?
The voltage leads the current by 45°.

(The net reactance is $X = X_L - X_C$ or $25 - 10 = 15$ ohms.
$\text{Tan}\ \phi = \frac{X}{\ } = \frac{15}{15} = 1$; $\phi = 45°$.)

150. What is meant by the "time constant" of a resistance-capacity circuit?
The time constant of such a circuit, when charging, is the time in seconds required for the voltage across the condenser to reach 63% of the applied e.m.f.; in discharging, for the voltage across the condenser to drop to 37% of its initial value. It is numerically equal to the product of resistance in ohms and capacitance in farads.

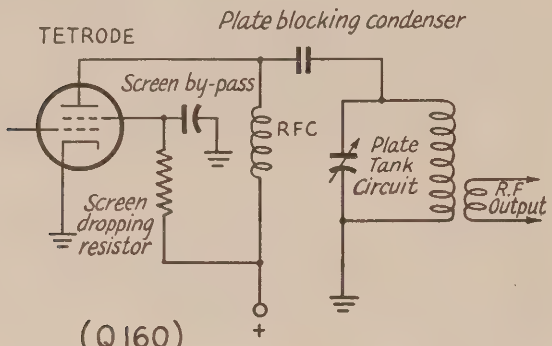
151. What effect does a loading resistance have on a tuned radio-frequency circuit?
It reduces the *Q* and thus broadens the tuning.

152. What is meant by the "*Q*" of a radio-frequency inductance coil?
The *Q* is a figure of merit of a coil and is equal to its reactance divided by its resistance at the frequency under consideration.

153. In frequency measurements using the heterodyne "zero beat" method, what is the best ratio of signal e.m.f. to calibrated heterodyne oscillator e.m.f.?
Equal values, i.e., 1: 1.

154. What is the purpose of neutralizing a radio-frequency amplifier stage?

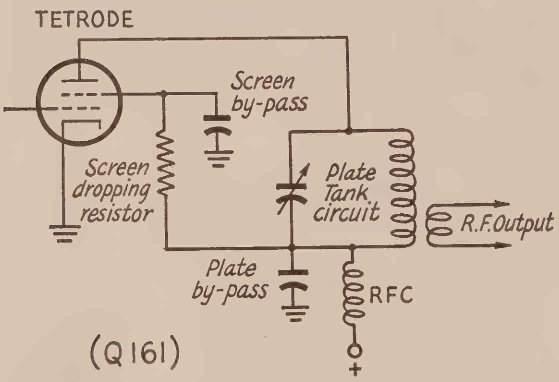
To avoid self-oscillation; also to prevent plate circuit reaction on the grid circuit, and to prevent feed-through from the grid circuit to the plate circuit.



(Q160)

155. What is the purpose of using an independent frequency standard?
To ensure that frequency measurements are made independently of the equipment being measured.

156. Discuss the characteristics of a modulated Class C amplifier.



(Q161)

In a Class C amplifier the power output is proportional to the square of the instantaneous plate voltage and the instantaneous d.c. plate current is proportional to the instantaneous plate voltage. Thus to an alternating voltage introduced in the plate circuit the tube behaves as a simple resistance. With transformer coupling to the modulator, a d.c. milliammeter in the plate circuit will show no change with modulation so long as the downward swing of the modulation does not exceed 100 per cent. This type of operation is achieved by using a bias voltage considerably beyond cut-off and driving the grid well into the positive region.

157. In adjusting the plate tank circuit of a radio-frequency amplifier, should minimum or maximum plate current indicate resonance?
Minimum.

158. What may be the cause of a decrease in antenna current during modulation of a Class B linear radio frequency amplifier?
See answer to Question 29.

159. With respect to the unmodulated values, doubling the excitation voltage of a Class B "linear" radio-frequency amplifier will result in what increase of radio-frequency power output?
R.f. power output will be quadrupled, since it varies as the square of the r.f. grid voltage.

160. Indicate by a simple diagram the shunt-fed plate circuit of a radio-frequency amplifier.

161. Indicate by a simple diagram the series-fed plate circuit of a radio-frequency amplifier.

162. How is the load on a modulator, which modulates the plate circuit of Class C radio-frequency stage, determined?
In the case of a Class B modulator, the plate-to-plate load on the modulator is equal to the Class C amplifier d.c. plate voltage divided by its d.c. plate current in amperes, the quotient then multiplied by the square of the primary-to-secondary turns ratio of the modulation transformer. With a Class A (Heising) modulator the load on the modulator is equal to the Class C amplifier d.c. plate voltage divided by its d.c. plate current in amperes. In either case the modulator must have a sine-wave power output equal to one-half the Class C d.c. plate input.

163. What are the results of using an audio peak limiter?
An audio peak limiter in a receiver holds signal and noise peaks to a predetermined level. This is useful in reducing the response to impulse-type noise which frequently has much greater peak amplitude than the desired signal, but low average energy content. In a transmitter, such a limiter permits a higher percentage of modulation without exceeding this percentage on peaks which otherwise might cause overmodulation.

164. What procedure should be adopted if it is found necessary to replace a tube in a heterodyne frequency meter?
The instrument should be recalibrated.

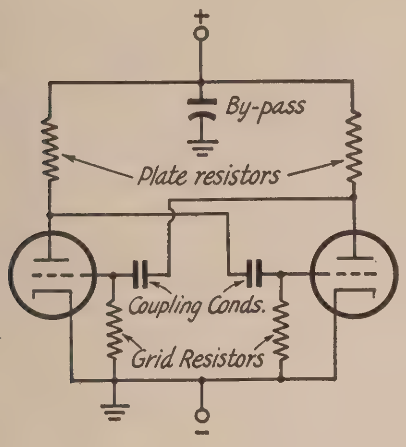
165. Why are crystals usually operated in temperature-controlled ovens?
To minimize temperature variations and the resultant changes in the crystal frequency.

166. What precautions should be taken to insure that a crystal oscillator will function at one frequency only?
Operate the oscillator with wide variations in temperature, plate tuning, etc., which might cause oscillation at a second frequency; if such occurs, operate the oscillator under conditions which do not produce such multiple oscillation.

167. Draw a simple schematic diagram of a multivibrator oscillatory circuit.

168. Why is it important to maintain the operating temperature of mercury-vapor tubes within specified limits?

To permit proper level of ionization for correct operation, and to prevent "arc-back."



(Q 167)

169. Why is it not advisable to operate a filter reactance in excess of its rated capacity?

To prevent magnetic saturation of the core, which reduces the inductance and thereby the effectiveness of the choke as a filter element.

170. How may a condenser be added to a choke-input filter system to increase the full-load voltage?

The condenser should be connected across the output of the rectifier system. This converts the filter from choke input to condenser input. The load current that may be taken safely from the supply when this is done is decreased because the peak currents are higher with condenser input than with choke input. In general, more *power* may be taken from a choke-input supply, even though the output voltage is lower, than from a condenser-input supply, because of the unfavorable ratio of peak to average current with the latter type.

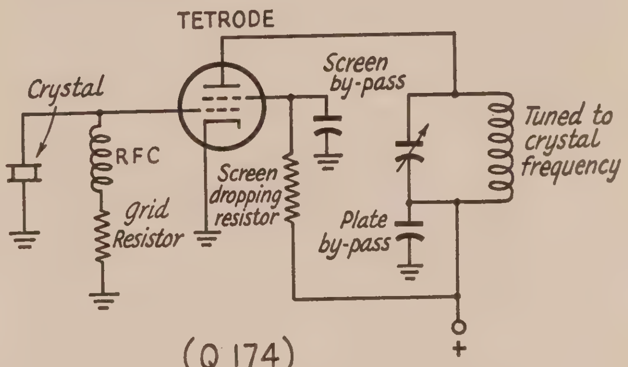
171. If, upon tuning the plate circuit of a triode radio-frequency amplifier, the grid current undergoes variations, what defect is indicated?

Improper neutralization, or the tube might have low cathode emission.

172. A certain transmitter has an output of 100 watts. The efficiency of the final modulated-amplifier stage is 50 per cent. Assuming that the modulator has an efficiency of 66 per cent, what plate input to the modulator is necessary for 100 per cent modulation of this transmitter? Also, assume that the modulator output is sinusoidal.

150 watts.

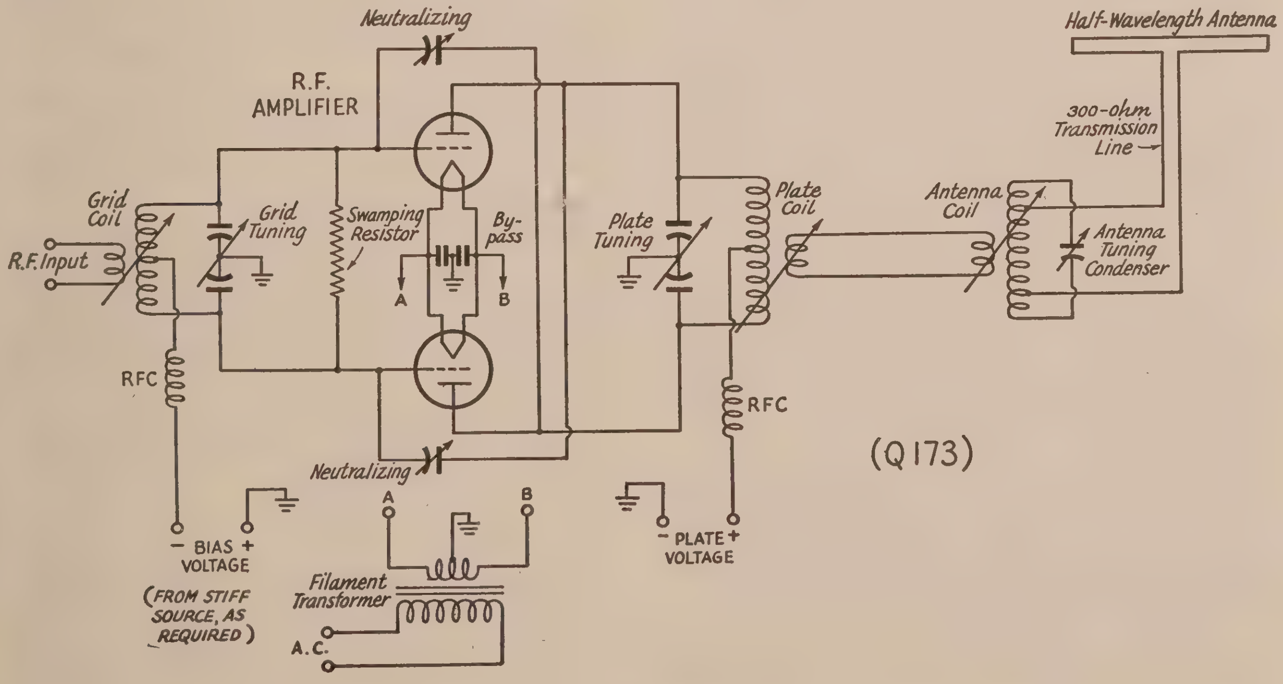
(If the amplifier is 50% efficient, it requires 200 watts to achieve the stated output. For 200 watts input power, 100 watts of modulator power is required. To obtain 100 such modulator watts from a 66% efficient unit, 150 watts of modulator input is necessary.)



(Q 174)

173. Draw a diagram of a Class B push-pull linear amplifier using triode tubes. Include a complete antenna coupling circuit and antenna circuit. Indicate points at which the various voltages will be connected.

174. Draw a diagram of a crystal oscillator.



(Q173)

175. If a transmitter is modulated 100 per cent by a sinusoidal tone, what percentage increase in antenna current will occur?

22.5%.

(The power will rise to 150% of its no-modulation value, and the current will rise in the ratio of the square root of 1.5, or 1.225.)

176. What is the antenna current when a transmitter is delivering 250 watts into an antenna having a resistance of 10 ohms?

5 amperes.

$$(P = I^2R, I = \sqrt{\frac{P}{R}} = \sqrt{\frac{250}{10}} = \sqrt{25} = 5)$$

177. If you decrease the percentage of sinusoidal amplitude modulation from 100 to 50 per cent, by what percentage have you decreased the power in the sidebands?

75%.

(Sideband power is proportional to the square of the modulation factor, so the ratio for any modulation percentage, M, is $\left(\frac{M}{100}\right)^2$. In this case $M = 50$, so $\left(\frac{M}{100}\right)^2 = 0.5^2 = 0.25$.

Since the power is one-fourth its value at 100% modulation, the power has been reduced by 75%.)

178. In a Class C radio-frequency amplifier stage feeding an antenna system if there is a positive shift in carrier amplitude under modulation conditions, what may be the trouble?

See Question 184.

179. Name four causes of distortion in a modulated amplifier stage.

Distortion in a modulated amplifier is always the result of nonlinear operation. In a plate-modulated amplifier non-linearity may be caused by (1) bias insufficient for Class C operation, (2) insufficient grid drive, (3) incomplete neutralization, (4) parasitic oscillations, (5) insufficient cathode emission, (6) overmodulation. Although not primarily a fault of the modulated stage, distortion also may occur because the modulating impedance is not adjusted to the proper value for the modulator, or can vary with frequency as in the case of inadequate output capacitance in the Class C stage plate supply. In a grid-modulated amplifier nonlinearity may be caused by (1) too-high plate efficiency at unmodulated carrier level, generally as a result of too-light plate loading and/or too-high grid drive, (2) improper value of bias voltage, (3) excessive resistance in fixed bias supply, (4) overmodulation. Distortion also may be caused if proper provision is not made for improving the regulation of the modulator, such as by "swamping" or by use of negative feed-back.

180. What percentage increase in average output power is obtained under 100 per cent sinusoidal modulation as compared with average unmodulated carrier power?

50%. (See Question 12.)

181. In a properly adjusted grid-bias-modulated radio-frequency amplifier under what circumstances will the plate current vary as read on a d.c. meter?

When the transmitter is overmodulated.

182. If tests indicate that the positive modulation peaks are greater than the negative peaks in a transmitter employing a Class B audio modulator, what steps should be taken to determine the cause?

Speech waveforms are usually unsymmetrical, so unequal positive and negative modulation peaks do not necessarily indicate that anything is wrong. Using a sine-wave audio signal for testing, the modulation envelope as shown by an oscilloscope also should be a sine-wave, in which event unequal peaks with speech, assuming neither peak exceeds 100 per cent, can be considered normal. If the positive peak is larger than the negative peak with the sine-wave signal, there are two probable causes: distortion in the audio system and regeneration in the modulated amplifier. The presence of the former can be determined by inspecting the output waveform of the modulator with the oscilloscope. If it is satisfactory, regeneration in the modulated stage is the likely cause.

183. What could cause downward deflection of the antenna current ammeter of a transmitter when modulation is applied?

Transmitter incapable of appreciable upward modulation. This could be caused by improper bias and insufficient excitation, or modulator overload, in the case of plate modulation. With grid modulation it is generally caused by adjusting the modulated amplifier for too-high plate efficiency under unmodulated carrier conditions.

184. In a plate-modulated amplifier, under what circumstances will the plate current vary as read on a d.c. meter?

Downward shift may be caused by:

a) Insufficient excitation.

b) Insufficient grid bias.

c) R.f. amplifier not properly matched to modulator.

d) Insufficient output capacitance in the filter of the modulated-amplifier power supply.

e) D.C. input to modulated amplifier in excess of manufacturer's ratings.

f) Filament emission low.

g) In plate-and-screen modulation of tetrodes or pentodes, the screen is not being sufficiently modulated along with the plate. If screen voltage is obtained through a dropping resistor, the screen by-pass may be too large.

h) Poor power supply regulation.

Upward shift may be caused by:

i) Overmodulation.

j) Incomplete neutralization.

k) Parasitic oscillation.

185. What is meant by low level modulation?

Low level modulation is that applied to an early or intermediate stage of a transmitter (instead of to the final amplifier) — i.e., at a point where the power level is comparatively low.

186. What are the advantages and disadvantages of Class B modulation?

The main advantages of Class B modulation are its high output, high efficiency, relatively low distortion, and ease of adjustment. Among its disadvantages are the driver power required for the modulator and the necessity for good audio driver regulation. Also, if the tubes used required fixed bias, the bias supply must have very low internal resistance. A plate supply with good regulation also is required, if distortion is to be kept to a minimum.

187. Draw a simple schematic diagram of a grid bias modulation system, including the modulated radio frequency stage.

188. What is the result of deliberately introduced degenerative feed-back in audio amplifiers?

Distortion is reduced; the frequency-response characteristics of the amplifiers are improved; the operation of the amplifier is less dependent on tube characteristics, and hum arising in the stages included in the feed-back loop is reduced. Care must be used in applying negative feed-back because phase shifts (usually at frequencies near the extremes of the audio range) in coupling circuits and transformers may change the feed-back at certain frequencies from negative to positive. Such phase shifts will cause self-oscillation unless the gain of the amplifier is too low, at the frequencies in question, to sustain it.

189. Under what circumstances will the gain-per-stage be equal to the voltage amplification factor of the vacuum tube employed?

When there is a transformer-coupled stage with a 1:1 ratio transformer, assuming the impedance of the transformer primary greatly exceeds the plate impedance of the tube.

190. If an a.c. series circuit has a resistance of 12 ohms, an inductive reactance of 7 ohms and capacitative reactance of 7 ohms, at the resonant frequency, what will be the total impedance at twice the resonant frequency?

15.9 ohms.

(Since $X_L = 2\pi fL$, doubling the frequency will double the inductive reactance to 14 ohms. Since

$$X_C = \frac{1}{2\pi fC},$$

doubling the frequency will halve the capacitive reactance to 3.5 ohms. The net reactance is $X_L - X_C$ or $14 - 3.5$ or a net X_L of 10.5 ohms. Impedance Z is the square root of the sum of the squares of resistance and net reactance, or

$$Z = \sqrt{12^2 + 10.5^2} = \sqrt{254.25} = 15.9 \text{ ohms.)}$$

191. What is the reactance of a condenser at the frequency 3550 kilocycles if its reactance is 300 ohms at 1805 kilocycles?

152.5 ohms.

(Capacitive reactance is inversely proportional to frequency, so

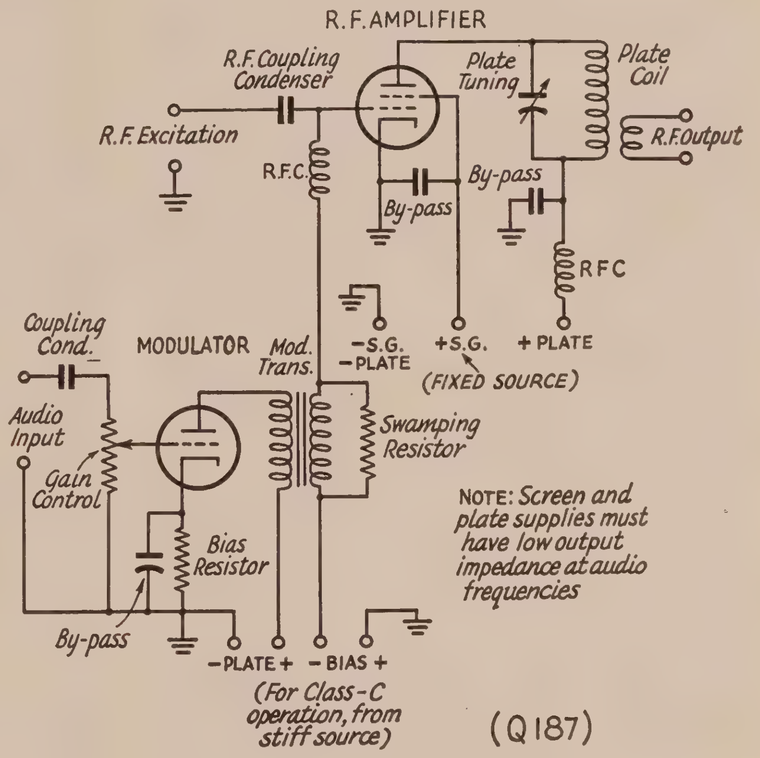
$$\frac{X_{C1}}{X_{C2}} = \frac{f_2}{f_1}, \text{ or } \frac{300}{X_{C2}} = \frac{3550}{1805} = 152.5 \text{ ohms.)}$$

192. If the mutual inductance between two coils is 0.1 henry, and the coils have inductances of 0.2 and 0.8 henry, respectively, what is the coefficient of coupling?

0.25.

(From $M = K\sqrt{L_P L_S}$, where M is the mutual inductance, K is the coefficient of coupling, L_P and L_S are the primary and secondary inductances. Transposing,

$$K = \frac{M}{\sqrt{L_P L_S}} = \frac{0.1}{\sqrt{0.2 \times 0.8}} = \frac{0.1}{\sqrt{0.16}} = \frac{0.1}{0.4} = 0.25.)$$



(Q187)

193. State what advantage, if any, a "folded dipole" antenna has over an ordinary half-wave antenna.

The folded dipole has broader frequency response characteristics, affords a close match to commercially available transmission line, and tends to discriminate against harmonics.

194. Describe a parasitic element of an antenna.

A parasitic element is one receiving power from a driven element by coupling through the electromagnetic field, rather than receiving power directly from the transmitter through a transmission line. It is usually similar in construction to a driven element and placed parallel to it at a distance which may be as much as one-half wavelength, but is generally less than one-quarter wavelength. It is usually tuned, by adjusting its length or by other convenient means, to give a phase relationship between the current induced in it and the current flowing in the driven element, to give a desired directive pattern for the system as a whole.

195. What physical arrangement of elements of an antenna array is known as collinear?

All elements lie in the same straight line.

196. Referring to antennas, does a "reflector" differ from a "director"?; if so, in what way?

A reflector increases radiated power in the direction from the reflector through the driven element; a director increases the radiated power from the driven element through the director.

197. Four types of transmission lines are commonly used to carry radio frequency power; name them.

There are only two basic types of transmission line, parallel-conductor and coaxial. However, there are numerous ways in which variants of these two are identified: air-insulated two-wire lines, with characteristic impedance varying from 450 to 600 ohms or so; air-insulated coaxial line; two-conductor solid-dielectric lines such as 300-ohm, 150-ohm, and 75-ohm twin-lead; solid-dielectric coaxial lines, flexible, and with impedances of 50 or 75 ohms, approximately; twisted-pair rubber-insulated lines; the single-wire feeder, which is essentially a two-conductor line with the ground supplying the return circuit; and four-wire lines, with conductors at opposite points of a square connected in parallel.

198. What causes a transmission line to show reactance at its input terminals?

A mismatch between the line and its load.

199. What causes a transmission line to show only resistance at its input terminals?

A perfect match between the line and its load; also, the line may be an exact multiple of a quarter wavelength and terminated in a resistive load.

200. Why is tuning equipment used at the input end of a transmission line?

To ensure adequate coupling to the line, including tuning out such reactance as may be present in the input impedance of the line.

201. Describe a method by which the direction of travel of a radio wave can be changed?

The most common process is essentially one of reflection. Such a reflector may be a discontinuity in the ionosphere or atmosphere, a man-made metal reflector, or a physical configuration of the earth.

202. Explain the relationship between "critical frequency" and "maximum usable frequency".

The critical frequency is a measure of the highest frequency that can be reflected vertically from the ionosphere. The maximum usable frequency is the highest frequency that can be used for a specified distance. The two are related by a factor that depends principally on the layer height and path distance. For the maximum distance of one-hop transmission (approximately 2000 km. for the E layer and 4000 km. for the F2 layer) the MUF is approximately 5 times the critical frequency for the E layer and 3 to 4 times the critical frequency for the F2 layer. The factors are smaller for shorter distances.

203. What determines the skip distance of radio signals?

The frequency and the state of the ionosphere.

204. State where antenna impedance is usually measured.

As a matter of convenience, at the point where the antenna is fed. The value so measured is frequently converted into an equivalent value at a current loop.

205. What precautions should be taken when working with or handling a magnetron to prevent weakening or damaging it?

Aside from precautions against breakage, care should be used to avoid mechanical shocks to the magnet, to keep other magnets or magnetic materials from its vicinity, and to keep the magnet away from high temperatures, these precautions being necessary to prevent weakening the magnet.

206. When installing waveguides, why should long perfectly level sections of waveguides be avoided?

To prevent accumulation of moisture which would cause surface discontinuities and result in higher losses.

207. Why are waveguides often used in preference to coaxial lines for the transmission of microwave energy?

The attenuation is less; in addition, they tend to act as high pass filters.

208. Draw a longitudinal section of a waveguide choke joint and explain briefly its principle of operation.

A waveguide choke joint has an L-shaped cavity that acts like a half wavelength of transmission line shorted at the far end. The voltage across the gap is zero and the current is equal to that in the guide walls. The leg of the cavity parallel to the waveguide is a quarter wavelength long, which offers a high impedance where the flanges join and prevents leakage at this point even when a poor or no electrical connection is present.

209. What is the peak power of a radar pulse if the pulse width is 1.0 microsecond, pulse repetition rate is 900 and the average power is 18 watts?

20 kw.

(In one second, the signal will have been on for 900 microseconds. So $\frac{x}{1} = \frac{18}{.0009} = 20{,}000$ watts.)

210. Which has the greatest signal handling capabilities, all other conditions being the same, a gridleak detector or a plate detector?
Plate detector.

211. How do operating conditions affect the input capacity of a triode amplifier?
Under operating conditions the input capacitance of a triode is equal to its grid-cathode capacitance plus added capacity which increases with the actual voltage amplification and the grid-plate capacitance of the tube.

212. How would you reduce frequency drift in an oscillator?
Operate at minimum practicable input; isolate components which generate sizeable amounts of heat; use negative-coefficient condensers to compensate for changes (usually positive) in circuit constants during operation; use insulating materials with low temperature coefficients.

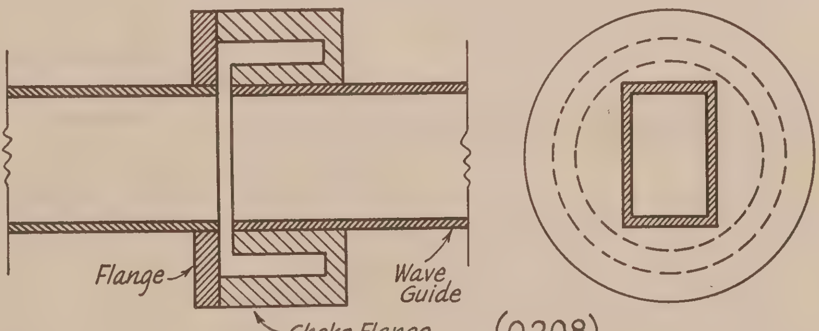
213. What is the difference between an "auto-transformer" and an ordinary transformer?
An auto-transformer has but a single winding, with one or more taps, while an ordinary transformer has at least two separate windings.

214. What is meant by coefficient of coupling?
The ratio of actual mutual inductance to the maximum theoretically possible value that could be obtained with two given coils. (See Q 192.)

215. What are three forms which a triode amplifier plate load may take?
Resistance, transformer, impedance.

216. When power is supplied to a circuit containing resistance and reactance, how much is dissipated in the resistance and how much in the reactance?
Only the resistance consumes power.

217. What is meant by the modulating impedance of a Class C plate-modulated amplifier?
The modulating impedance is the load resistance presented to the modulator by the r.f. amplifier, and is equal to the d.c. plate voltage divided by the d.c. plate current in amperes.



(Q208)

218. How is radio frequency in an audio system likely to be indicated?
By overloading, distortion, and unwanted oscillations.

219. Define a "back-wave" and explain what causes it.
A back-wave is a signal emitted during key-up conditions. In make-break keying, it may be caused by energy from unkeyed exciter stages leaking through a keyed amplifier (because of improper neutralization, etc.) or by parasitic oscillation. In frequency-shift keying the "space" signal is the back-wave.

220. If an intermediate frequency amplifier in a superheterodyne receiver is made regenerative what advantages may be expected?
Greater selectivity, better signal-to-noise ratio.

221. What disadvantages occur when an intermediate frequency amplifier in a superheterodyne receiver is made regenerative?
The regenerative gain and the selectivity are dependent on signal strength.

222. What constants of a transmission line determine its "characteristic impedance"?
The inductance and capacitance per unit length. These quantities are determined by the size of the conductors, the spacing between them, and the dielectric.

223. In what respect does a nonresonant transmission line differ from a resonant transmission line?
A line is nonresonant when the load is matched to its characteristic impedance; a line is resonant when it operates with an appreciable standing wave ratio.

224. What are "deviation" and "deviation ratio" as applied to frequency modulation?
Deviation is the peak difference between the instantaneous frequency of the modulated wave and the carrier frequency. Deviation ratio is the ratio of the maximum frequency deviation to the maximum modulating frequency of the system.

225. What methods may be used to deflect an electron beam in a cathode-ray tube?
Either electric or magnetic fields.

226. Compare suppressor-grid modulation with grid-bias modulation.
Basic operation is similar, in that both ac-

complish modulation by varying the amplification of the r.f. tube in such a way that the r.f. output amplitude is directly proportional to the instantaneous amplitude of the modulating voltage. This requires that the plate power input and plate efficiency vary properly with the modulating voltage. When the operating point is properly chosen, little or no current flows in the suppressor grid circuit, so negligible power is required from the modulator. Grid current flows during part of the modulating cycle when the control grid is modulated. This requires some power from the modulator, and since the load on the modulator is variable it is desirable to include provision for additional loading or "swamping" in the modulator circuit, to prevent distortion of the audio waveform.

227. Why is the tuning range of a communications receiver divided into bands?

In order to provide for satisfactory tuning rates and in order to maintain more favorable *LC* ratios throughout the frequencies covered.

228. If correct tracking is to be achieved in a receiver's tuned radio frequency-amplifier stages what requirements must be met?

True tracking can be obtained only when the inductance, tuning condensers, and circuit inductances and minimum and maximum capacities are identical in all "ganged" stages.

229. What method is usually used to obtain grid bias in an oscillator circuit?

The oscillator tube generates its own bias by means of a grid leak.

230. What may cause the primary to be thrown out of tune when the coupling between two radio-frequency circuits is increased?

Reactance is coupled into the primary, changing its resonant frequency.

231. What undesirable effects may result from a self-oscillating buffer amplifier in a transmitter?

Self-oscillation of a buffer amplifier may cause the emission of spurious frequencies.

232. What type amplifier and class of operation is usually preferred for a frequency doubler?

A single-ended type amplifier operating Class C is usually preferred.

233. Why is it advisable to use a separate plate-power supply for the oscillator of a multistage transmitter?

A separate plate-power supply for the oscillator minimizes plate-voltage variation and thus provides a higher degree of frequency stability.

234. What is the most useful operating characteristic of a "push-push" type of amplifier?

The principal output frequency is twice the excitation frequency. Hence the "push-push" type of amplifier, with the grids of two tubes connected push-pull and the plates in parallel, can be used as a frequency doubler.

235. What are the operating characteristics of the electron-coupled type oscillator with regard to frequency stability?

The electron-coupled type oscillator has better frequency stability with varying supply voltages and load conditions than other types of self-controlled oscillators.

236. What circuit conditions will minimize the harmonic components in the output of an r.f. power amplifier?

A large capacitance-to-inductance ratio in the plate tank circuit, along with relatively low grid bias and the minimum excitation voltage necessary for reasonably good efficiency, will minimize harmonic output.

237 What is the principal disadvantage of using a grid leak as the only source of bias in a Class C radio-frequency power-amplifier stage?

Loss of excitation will cause loss of grid bias and an increase in the plate current.

238. What are the relative merits of triodes and screen-grid tubes as r.f. amplifiers?

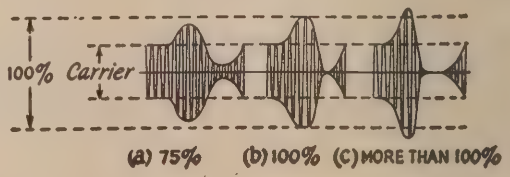
Although triodes are generally more easily loaded and are better adapted to plate modulation, they require an external neutralizing circuit to prevent feed-back and self-oscillation while screen-grid tetrodes and pentodes normally do not require neutralization because their internal grid-plate capacitance is sufficiently reduced by the screen-grid.

239. Show by a diagram the sinusoidal modulation envelope of an amplitude-modulated wave:

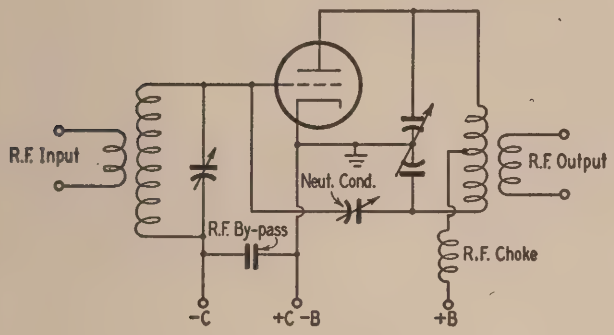
(a) Modulated approximately 75%.

(b) Modulated 100%.

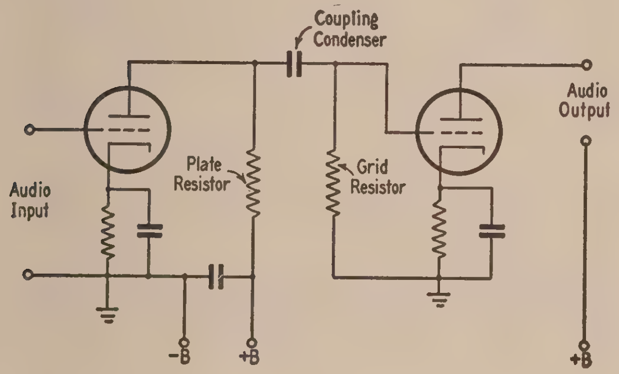
(c) Modulated more than 100%.



240. Draw a diagram of a plate-neutralized triode r.f. amplifier stage.



241. Draw a diagram of a coupling system between two audio-frequency amplifier stages, employing resistance elements.



242. What are the principal reasons for using a choke-input type filter in a power-supply system employing mercury-vapor rectifier tubes?

The principal reasons for using a choke-input type filter are to obtain good voltage regulation and to limit the peak current through the rectifier tubes.

243. Would mercury-vapor or high-vacuum type rectifier tubes of equivalent ratings be preferable for a power supply in which filament and plate voltages must be applied simultaneously? Give the reason for your choice.

High-vacuum type rectifier tubes would be preferable because plate voltage may be applied safely without time delay for the filaments to reach operating temperature.

244. What visible operating characteristic distinguishes mercury-vapor rectifiers?

The mercury-vapor tubes show a bluish-green glow when operating normally under load.

245. Why are mercury-vapor type rectifier tubes more critical as to observance of anode voltage rating than high-vacuum type rectifiers?

The mercury-vapor tubes have a critical peak inverse voltage rating which must not be exceeded in operation, while with the high-vacuum type rectifier the peak inverse voltage is limited only by the insulation of the tube.

246. What advantage has a push-pull audio-frequency amplifier over a single-tube Class A amplifier of similar excitation requirement and equal power output?

Even harmonics are not generated in the output circuit of a properly balanced push-pull amplifier.

247. What are the distinguishing operating characteristics of a Class A type amplifier?

In a Class A amplifier the grid bias is adjusted for operation over the linear range of the grid-voltage plate-current curve so that the output is a faithful reproduction of the input voltage wave form. The average plate current remains constant. The grid normally is not driven positive. Hence the grid draws no current. The plate efficiency is relatively low.

248. What improper operating conditions are indicated by upward or downward fluctuation of Class A amplifier plate current when signal voltage is applied to the grid? What correction should be made?

Upward fluctuation of Class A amplifier plate current with excitation indicates excessive negative grid bias; hence, the grid bias should be decreased. Downward fluctuation of plate current with excitation indicates insufficient negative bias; hence, the bias voltage should be increased to correct this condition.

249. Why is bias voltage generally necessary on the grid of an audio amplifier tube, and what is the principal result of improper bias?

A negative grid-bias voltage is generally necessary to obtain operation over the proper portion of the grid-voltage plate-current characteristic curve of the amplifier tube. Improper bias results in distortion of the wave form in the output of the amplifier.

250. What improper operating conditions are indicated by grid-current flow in a Class A amplifier?

Grid current flow in a Class A amplifier indicates either excessive excitation voltage or low negative grid bias, or a combination of both.

251. What is the principal advantage of a Class B audio amplifier as compared to other types?

Because of its higher efficiency at maximum output and its low plate-power consumption when idling, the Class B audio amplifier is more economical of power than a Class A type amplifier. Because of its relatively low distortion it is, of course, preferable to a Class C audio amplifier.

252. How should the average plate current vary in a properly-designed and operated amplitude-modulated radio-frequency power amplifier?

The average plate current of the modulated r.f. amplifier should remain constant with any constant-carrier system, regardless of the method of modulation.

253. What are the notable efficiency and distortion characteristics of a Class B modulator employing two triodes in push pull?

The outstanding characteristic of the Class B modulator is its high efficiency in combination with relatively small distortion.

254. How do the excitation requirements of a Class B modulator compare with those of a Class A modulator having equal grid-voltage swing?

The Class B modulator requires greater driver power because the grids are swung considerably positive and draw current on the excitation peaks.

255. What would happen if the grid-bias supply of a Class B modulator was suddenly short-circuited?

The loss of grid bias resulting from the short circuit would cause the plate current to jump to an excessively high steady value and damage to the tubes might result if the plate dissipation was sufficient to cause the tubes to show abnormal color.

256. What is the ratio of modulator audio power output to Class C amplifier unmodulated plate power input in a plate-modulation system:

(a) With a sinusoidal signal?

(b) With a two-tone signal equivalent to speech?

(a) 50% with sinusoidal audio power.

(b) Approximately 25% with a complex signal equivalent to speech.

257. Define amplitude modulation.

Amplitude modulation is the process by which the amplitude of the radio-frequency carrier wave is varied in accordance with the amplitude of the speech or other signal to be transmitted.

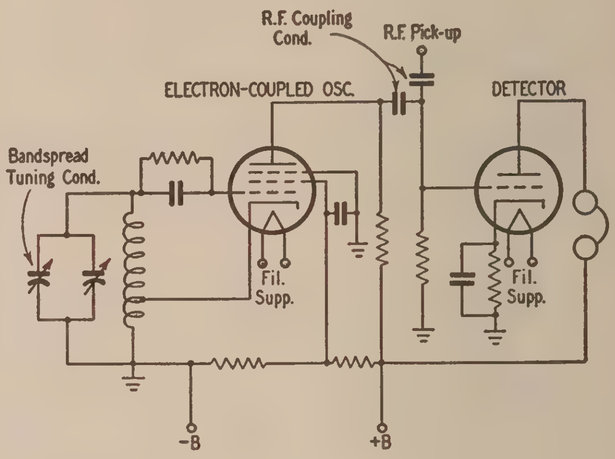
258. What are sideband frequencies?

Sideband frequencies are frequencies above and below the carrier frequency, and equal to the sum and difference of the modulation and carrier frequencies, which are produced by the process of modulation.

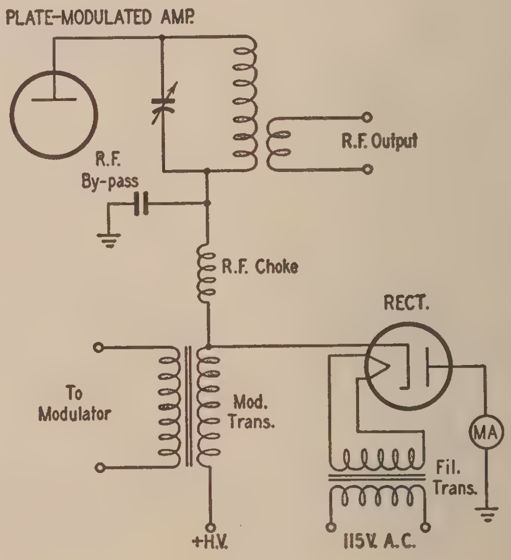
259. What radiotelephone transmitter operating deficiencies might be indicated by downward deflection of the antenna r.f. current meter during modulation of the final r.f. amplifier?

Downward deflection of the antenna r.f. ammeter might indicate insufficient r.f. excitation to the modulated r.f. stage, inadequate filament emission in the tubes of the modulated r.f. amplifier, or very poor voltage regulation of a power supply common to both modulator and r.f. amplifier.

260. Draw a schematic diagram of a combination heterodyne frequency meter and monitor.



261. Draw a simple schematic diagram of a peak modulation monitor which will indicate when 100% modulation occurs or is exceeded.



262. Using a frequency meter with a possible error of 0.75%, on what whole-number kilocycle frequency nearest the low-frequency end of the 14,000–14,350-kc. band could a transmitter safely be set?

The whole-number kilocycle frequency nearest the low-frequency end of the 14,000–14,350-kc. band is 14,106 kc.

Note: For precise calculation of the frequency on which the transmitter can be set with a given percentage tolerance, the formula to be used is

$$f_x = \frac{f_L}{1 - n}$$

where f_x is the frequency on which the transmitter is to be set
f_L is the lower-limit frequency of the band
n is the given percentage error expressed as a decimal

For this question, the equation is

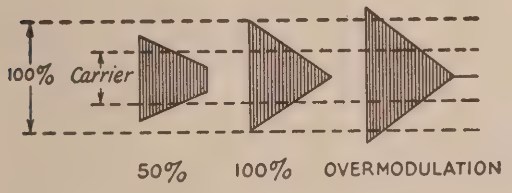
$$f_x = \frac{14{,}000}{1 - 0.0075} = \frac{14{,}000}{0.9925} = 14{,}105.8$$

The nearest whole-number kilocycle frequency which will be safely within the band for this tolerance is 14,106 kc.

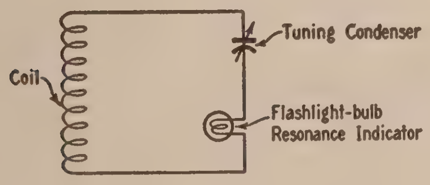
263. What particular precaution should be observed in using a battery-operated heterodyne frequency meter?

The "A" and "B" battery voltages should be checked because a change in battery voltage will affect the oscillator frequency.

264. Draw the trapezoidal type patterns showing 50% modulation, 100% modulation and over-modulation as they would appear on the screen of a cathode-ray oscilloscope properly connected to a 'phone transmitter.



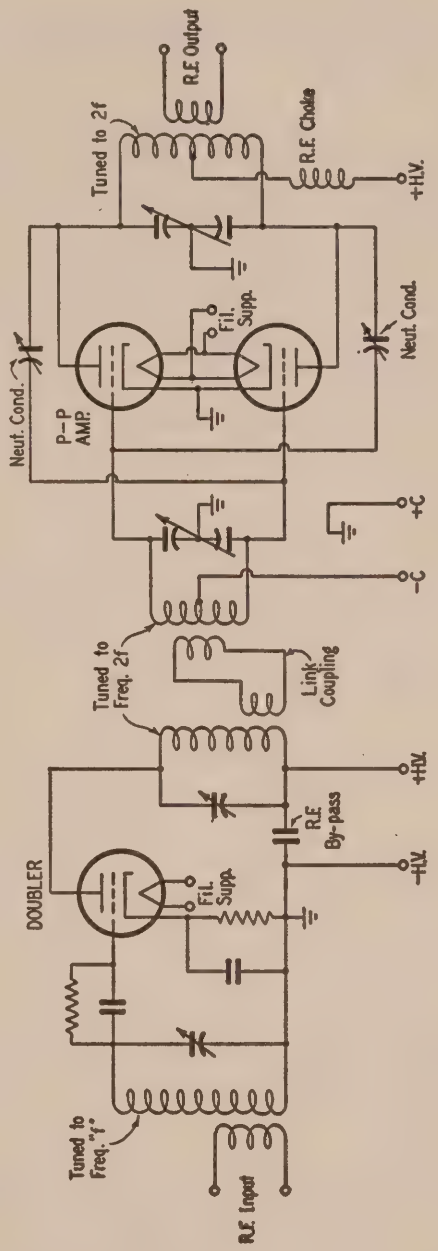
265. Draw a diagram of an absorption-type frequency meter including a resonance indicator.



266. Two filter chokes have the same inductance, current and insulation voltage ratings but one has twice the resistance of the other. Which would be preferable for use in a transmitter power supply and why?

The filter choke with the lower resistance would be preferable because the output voltage would have better regulation than with the higher-resistance choke.

267. Draw a simple schematic diagram of a radio-frequency doubler stage driving a neutralized push-pull power amplifier using triodes, showing the method of interstage coupling and indicating the relative resonance frequencies of the grid and plate circuits.



268. Using a frequency meter with a possible error of 0.75%, on what whole-number kilocycle frequency nearest the high-frequency end of the 14,000–14,350-kc. band could a transmitter safely be set?

The whole-number kilocycle frequency nearest the high-frequency end of the band is 14,243 kc.

Note: The formula for calculating the precise frequency on which a transmitter may be set nearest to the high-frequency end of the band for a given percentage tolerance is

$$f_x = \frac{f_U}{1 + n}$$

where f_x is the frequency on which the transmitter is to be set

f_U is the upper limit of the band in kilocycles
n is the percentage tolerance expressed as a decimal

For the present question,

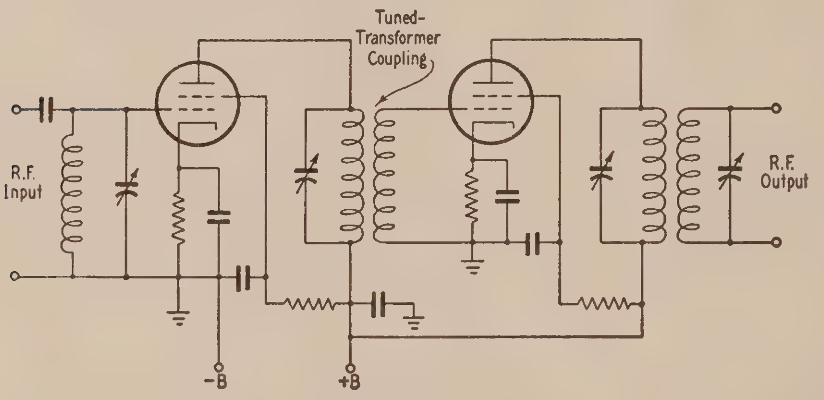
$$f_x = \frac{14,350}{1.0075} = 14,243.1$$

The nearest whole-number kilocycle frequency safely inside the band for this percentage tolerance is 14,243 kc.

269. What particular precaution should be taken in using an absorption-type frequency meter to check a self-excited oscillator?

The frequency meter should be very loosely coupled to the oscillator tank circuit so that the frequency calibration of the meter will be affected as little as possible by mutual coupling to the transmitter circuit.

270. What is the purpose of using a quartz crystal in a transmitter?



The quartz crystal determines and stabilizes the oscillator frequency.

271. Draw a schematic diagram of a two-stage r.f. amplifier using screen-grid tubes, showing a suitable method of interstage coupling.

272. What would be the visible results of a short-circuited filter condenser in a plate power supply with high-vacuum rectifier tubes and an unfused primary circuit?

The rectifier tube plates would become red-hot in operation.

273. What precaution should be taken to protect filter condensers connected in series?

Resistors having a value of approximately 100,000 ohms should be shunted across each condenser to equalize the d.c. voltage drops and thus prevent breakdown of the individual capacitors.

274. Why is a full-wave rectifier preferable to a half-wave rectifier?

The full-wave rectifier output is easier to filter because of its higher ripple frequency.

275. What constructional precaution should be taken to insure stable operation of a transmitter having one or more neutralized amplifier stages?

Isolation of the stages from each other should be provided, either by interstage shielding or adequate physical separation of the individual stages.

276. Explain the purpose of using a center-tap return connection on the secondary of a transmitting tube's filament transformer.

The filament center-tap connection is used to prevent modulation of the emitted carrier by the alternating-current filament supply.

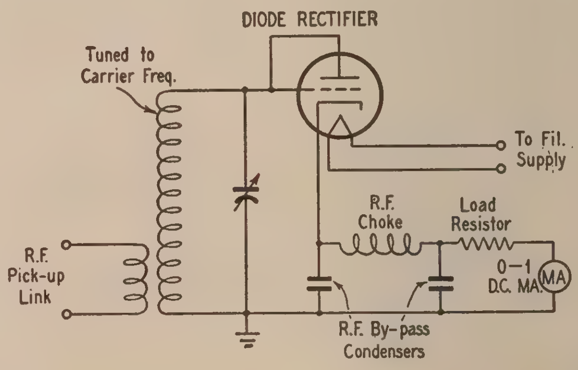
277. On what amateur frequencies is wide-band frequency or phase modulation permissible?

In the bands 26.96-27.23 Mc., 29-29.7 Mc., 52.5-54 Mc. and on all amateur frequencies above 144 Mc. (§12.111).

278. On what amateur frequencies is narrow-band frequency or phase modulation for radiotelephony permissible?

On all amateur bands above 2000 kc. where voice emission is permitted.

279. Draw a schematic diagram of a simple device for checking carrier shift of a radio-telephone transmitter.



CHAPTER 8

The Station License

THE station-license part of the combined license is the station's "registration." It licenses a collection of apparatus at a particular address (with certain restricted portable and mobile privileges, however) to be operated as an amateur station in the amateur frequency bands. It designates the official call to be used. It is secured by filling in those portions of the combined license-application form which deal particularly with the station-license application. It is not necessary to show possession of equipment before obtaining a license. You can get your transmitting gear later. There is no separate examination for a station license; it will be issued along with your operator license.

Although the specific prohibition of amateur stations on premises controlled by an alien has been dropped from our rules, you must still be able to show control of the premises where the station or its control point is to be located. If you are an American citizen and own your own home you may have a station there. If you are a citizen, renting the house or apartment where you live, you may have a station there, since your rental of the property brings it under your control. You may have a station in your own office, since you control that; and, even though you be a minor, you may have one in your own home. For stations on institutional premises, a consent signature is required.

The station license should be at hand whenever the station is being operated. If your station is to be operated by someone in your absence, either leave your license at your station or have a photocopy of the authorization made and post that in your shack.

IMPORTANT: The extent of privileges under which a station may be operated depends not only on the class of operator license of the person doing the operating, but also on the class of operator license of the station licensee. When operating your own station, of course this is no problem since the privileges in both operator and station license are the same, but the dual-license responsibility must be observed when visiting another station, or when yours is operated by a visiting amateur. For example, a station owned by a Novice or Technician Class licensee may not be operated in the General Class bands even though a General (or higher) Class operator is present and in charge of the equipment. Let us give some further illustrations. Any licensed amateur radio operator, other than Technician Class, may visit a Novice station and operate the transmitter in the Novice bands under Novice rules, but in no other bands. Now, the Novice operator may pay a return visit to, say, an Advanced Class operator's station; he (the Novice) may operate the Advanced Class station only in the Novice bands, provided the transmitter is crystal-controlled and does not exceed 75 watts input. A Technician may visit any amateur station other than Novice Class and operate it in any bands above 220 Mc. Conditional, General, Advanced and Amateur Extra Class licensees, since they hold "unlimited" privileges, may of course operate any amateur station, but only to the extent of privileges authorized in the operator license of the station licensee. The station license runs concurrently with the operator license and like the latter has a term of five years. It may be renewed, as is outlined later. EXCEPTION: Novice Licenses, with a term of one year, may not be renewed.

Modifications

If you change permanent residence by moving to another address in the same city, or to another part of the state, or into another state, you must apply for a "modification" to authorize the new address. The procedure for this is the same as an original application except that of course you do not have to pay any attention to those portions of the application form relating purely to the *operator* license privileges. Write your district Engineer for the usual amateur application form and fill out the "station" part as usual, except that it is now designated at the top as an application for modification.

When you have filled out the form, mail it, together with your existing license, to the Federal Communications Commission, Washington 25, D. C., not to the Engineer. Modifications of this type no longer result in extensions of the license period.

Of course, if at the same time that you want to change the address of your station it is necessary for any reason for you to take an operator examination before the Engineer, you would not mail any of the forms direct to the Commission. You would return them to the Engineer and await his instructions when to appear for personal examination. Direct return to the Commission is in order only when no personal appearance is required.

When your licenses have been mailed in for modification, you may continue to operate until the new ticket is received with this one exception: If you are modifying to change the station address, the period that you may operate without the station license in your possession must not in any case exceed four months, and portable procedure must be used meanwhile. See §12.93(a).

Renewals

The station license (except that of a Novice, which is not renewable) is customarily renewed simultaneously with the operator license. Proof of activity is required in connection with renewing an operator license, as described in Chapter 1, but such operating activity need not take place from your own station. There is, therefore, no proof-of-use required in the renewal of a station license. Filling out the application Form 405-A (or 610) for renewal of operator license completely will also result in renewal of your station license. You may continue operation of the station while your ticket and application for renewal are on file and being processed by the Commission; in fact, if FCC delays processing your application (perhaps for reason of overload) you may continue to operate past the expiration date until you have definite word from the Commission as to what action was taken on your application.

Portable and Mobile Operation

The possession of a station license automatically authorizes you to operate a portable or mobile station, within the continental limits of the United States, its territories or possessions, on any amateur frequency authorized to your class of license. If such portable or mobile operation involves a period of more than 48 hours away from the home location, you must give advance notice to the FCC Engineer in whose district you will be (see page 6 for data on district boundaries and addresses). If operation away from the home base is less than 48 hours, no notification is required. It is important to note a slight difference between the requirement for portable and that for mobile, as provided in §12.91(a). In portable work, if the *over-all* period of such operation is more than 48 hours, notification is required even though the station may be operated part of the time at the fixed location. What this means is that if you decide to go portable at your summer camp for a week or two you can't escape the requirement for notification just because you may be planning to come back home every day or so to do a little operation at the home location. However, if you work mobile, but never more than 48 hours before you come back home, you never need to notify. This differentiation is to permit such things as mobile operation to and from one's daily job without the need of a steady flow of notifications.

When you notify the FCC district office of intended portable operation, the notice is valid for one month; if you operate away from home for longer than a month, you must send additional notices each month. There is no longer a four-month limit on portable operation at any one location. For either mobile or true portable operation, while you have to send in a notice each month you're away, you can keep it up indefinitely. However, if you move bag and baggage to a temporary location, such as going away to college, you should not operate under the portable privileges but under a special arrangement for temporary operation, for details of which see situation #2 in the following section.

For amateur operation aboard ships or aircraft, see the special provisions in §12.94. For amateur operation outside the continental limits of the U. S. and possessions, permissible only in the band 28–29.7 Mc. see §12.91(b) as well.

When operating either portable or mobile, be sure to have your combination license with you while operating equipment under your own call. If not operating your own portable equipment, be sure that you have with you either the original combination license for the call under which the portable equipment is being operated, or a photocopy of the station authorization for that call. This, of course, is in addition to your own original operator license, which you must also have with you. If you have a portable station operating under your call but not being operated by yourself, see to it that whoever is doing the operating has either your combination license or a photocopy of the station authorization with him. You should also be sure such operator is licensed and has his own operator license with him, since you are legally responsible for the proper operation of equipment being operated under your call. Logs must be kept in all cases, and must show the approximate location at each transmission. Moreover, the calling procedure specified in §12.82 of the rules must be closely followed.

Do not operate an unlicensed fixed station under your own call as a "portable," as this constitutes illegal operation. Nor should you operate a licensed fixed station other than your own under your call on a portable basis; your call and your station license apply only to your own station and cannot be used in connection with the fixed station of someone else. In such circumstances, use his call, and see to it that you not only have your own operator license with you but that a photocopy of his station license, or the license itself, is in the operating room.

Temporary Operation

Portable procedure is ordinarily confined to truly portable apparatus but there are two conditions under which your own fixed station may be operated temporarily in portable status. These are:

(1) While awaiting receipt of modified license after you have moved your station to a new permanent location and asked for modification. See §12.93(a) of the rules. Such operation cannot be continued more than four months nor beyond the license's expiration. You must send *monthly* notification of the circumstances to the FCC Engineer concerned, as required by §12.91(a), and must use portable calling procedure as specified in §12.82. See also the discussion under "Modifications."

(2) When, as during a vacation, for instance, you have set up your fixed station at some temporary address but with the intention of returning after a short time to the address specified on your

license, or of shortly moving to still another fixed location. Other examples of such situations would be a person going away to college, or an amateur in military service irregularly being transferred from one post to another. So long as you maintain a permanent residence, your station license should show that address, and you should not apply for modification unless you change your *permanent* address. Moves to temporary locations, even though they involve extended absences from your permanent address, are provided for in §12.93(b). You simply give advance notification both to the Engineer in Charge of the radio inspection district in which you are to operate (see list in Chapter 1) and to FCC in Washington, stating your call, name, your permanent address and the one at which you are going to operate "temporarily," affirming that this is not a permanent change of residence, and indicating the address at which you can be readily reached. If such operation continues more than one month, additional such notices are required each month to the Engineer only. When you move back to your permanent residence or to still another temporary one, the double notice is required. In addition, you should send a double notice if you are in temporary status and then move to a new permanent location; in that case you should also immediately apply for modification of your license. When operating under these "temporary" privileges, you must employ the portable calling procedure as indicated in §12.82.

Remote Control

While most amateur stations are controlled from the same address at which the transmitter is located, some amateurs desire to control their stations from a remote operating point. As this requires some special precautions, special FCC authority is necessary, each case being considered on its merits. See §12.64 of the rules for the technical conditions necessary for obtaining authority to operate without an operator on duty at the transmitter location. In an initial application for a new station using remote control, your answer to Question 17 of the application form will supply most of the required data, although you may find it desirable to explain some of your arrangements by an accompanying letter. If you are already licensed without remote control, and desire to install same, you must apply for modification of your station license to authorize the changes and to put the data on record through your responses to Question 17.

Station Call Signs

The basic principles of formation of amateur call signs are outlined in the Atlantic City (1947) world conference documents. It is there provided that an amateur call sign must be made up of one or two letters (the first in some instances may be a numeral) as a prefix, then a numeral, and then a suffix of not more than three letters. In the United States, both the initial prefix letters W and K are available for civilian use. For amateur purposes, the continental U.S.A. is divided into ten call districts, 1 through 0. It has been the practice to issue amateur calls with W prefixes in the continental U.S.A. and with K-letter prefixes for the territories and possessions. The indicators are shown in the adjoining box.

U.S. Possessions Prefixes

KB6	Baker, Howland & American Phoenix Islands
KC6	Caroline Islands
KC6	Palau Islands
KG4	Guantanamo Bay
KG6	Mariana Islands
KH6	Hawaiian Islands
KJ6	Johnston Island
KL7	Alaska
KM6	Midway Islands
KP4	Puerto Rico
KP6	Palmyra Group, Jarvis Island
KR6	Ryukyu Islands (e.g., Okinawa)
KS4	Swan Island
KS6	American Samoa
KV4	Virgin Islands
KW6	Wake Island
KX6	Marshall Islands
KZ5	Canal Zone

FCC assigns station calls in strict progression and entertains special requests from individual amateurs only under the following circumstances: (1) If your call area is being changed, you will be given the counterpart call in the new area if it be still available. (2) If you move into another call area, FCC will give you the counterpart call if feasible. (3) You can recover a previously-held call if you are its last recorded holder or if it has been unheld for five years. (4) If you have ever held a two-letter call, you can get one now, either on a new application or by modification of an existing license. See §12.81.

Novice call signs are distinctive. In the continental U.S.A. the prefix will be WN or KN, with the usual numeral indicating the call district, and a suffix of three letters taken from the regular series. If and when the Novice graduates to a standard five-year term license, the N is dropped from the prefix so he has a "standard" call. For example, a successful Novice applicant from Texas might get the call WN5TRD, good for one year; when he qualifies for a higher grade of license, his call becomes W5TRD. In possessions and territories, calls for Novices will be issued from the regular series but with a W-letter prefix instead of a K-letter prefix. For example, a Novice in Hawaii might have the call WH6BD, one in Puerto Rico WP4KD, and so on. When he qualifies for a regular grade license, the Commission issues a call identical except the W is changed to a K.

Antenna Height Regulations

A portion of the FCC rules governing the amateur service has to do with restrictions, under certain specified conditions, of the height of amateur antennas. The purpose of these rules is to decrease air navigation hazards. These restrictions will probably apply only to a very small percentage of amateurs, but it is necessary for you to be aware of these conditions in order that you may be sure that your own planned installation lies within the limits of the law.

Reference to §12.60 will give you the conditions under which certain additional application must be made. Few, if any, amateurs have antennas exceeding 170 feet in height, and so whether or not you are affected will probably be determined by your location with respect to an airport and whether the proposed antenna exceeds one foot in height for each 200 feet of distance from the nearest boundary of an airport. First of all, if your proposed antenna (note that these rules do not apply to antenna structures which were in existence prior to February 15, 1951) is to be mounted less than 20 feet above the ground or less than 20 feet above a house or other supporting structure, you are not affected by these rules. However, if you should live 4,250 feet from the nearest boundary of an airport, you could not put up an antenna over 21 feet high without first filing FCC form 401-A. Under certain conditions the FCC will require that an aeronautical study be made, to determine if the proposed antenna is a hazard to air navigation.

Citations

FCC has an extensive monitoring system, and occasionally an amateur will be found in some infraction of the amateur regulations. In minor cases, such as harmonics falling within another amateur band, the amateur will receive only an "advisory notice" from the Commission, pointing out the discrepancy in his operation. Such a notice does not require a reply, serving merely to warn the amateur of the existence of a condition which is not in the strictest accord with the rules, but is not considered a serious violation. In more serious matters, the Commission will send the offending amateur an official citation, which requires a reply within three days. A pink or salmon-colored form is used, in general, for notices dealing with off-frequency operation, spurious emissions, and the like, while a green form is used in cases of violation of operating regulations such as improper signing of call letters, etc.

These advisory notices and official citations are sent to the licensee of the station being operated. In other words, if some amateur friend of yours improperly operates your station, *you* are the one to whom the Commission will write, and who is obliged to make response.

If you should receive an advisory notice, you should act promptly to clear up the condition which causes the discrepancy. If you should receive an official citation, follow its instructions to the letter. The Commission will usually accept any rational explanation of a rules infraction, so long as the reply asserts that steps are being taken to prevent a recurrence; but nothing is more serious than ignoring a citation or failure to answer it completely.

If you have TVI, you may receive form letters from the Commission, perhaps based on a complaint by a neighbor, asking you to cooperate in clearing up the trouble. Receipt of such a letter does not indicate that the Commission necessarily believes you are at fault; it is simply attempting to advise you of the complaint and to obtain your cooperation in working with your neighbor to clear up the trouble (the neighbor receives a form letter from FCC also). In difficult situations which sometimes arise in fringe areas you may be plagued with several such notices in the course of time, but there is only one thing to do and that is to answer each one promptly and fully. On your cooperativeness and promptness and completeness in replying will often rest the Commission's judgment of your position in the matter.

Quiet Hours

If an amateur station causes TVI and BCI over a general area and it is not cleared up reasonably, the FCC may impose quiet hours on the amateur. This is seldom done except in instances where the amateur is uncooperative, or has not altered his transmitting equipment to an extent deemed necessary in the Commission's judgment. The first order for such quiet hours will keep the amateur off the air between the hours of 8 p.m. and 10.30 p.m., local time, each evening, and additionally between 10.30 a.m. and 1.00 p.m. on Sundays. If these restrictions are not enough to ensure peaceful neighbors, and the amateur fails to show an ability to reasonably improve his interference problems, FCC may impose stiffer quiet hours. (See §12.152, 12.153 and 12.154.) If you have the misfortune of the imposition of quiet hours, the restriction can be removed at such time as you clean up the interference and demonstrate that fact to FCC.

Amateur Station Uses

The most obvious aspect of amateur operation is the direct contact with other amateur stations; ragchewing, working DX, etc. There are, however, certain other amateur operating activities that should be mentioned briefly.

Amateurs may use their equipment to control models such as airplanes and boats. There are no special provisions for this type of work, but you must remember to properly log your transmissions, and you must identify your call every ten minutes (as indeed you must in any type of amateur work). (See §12.101) This type of operation may be counted when applying for a renewal.

One-way transmissions are in general prohibited. For instance, you can't legally get on 'phone and "broadcast" a message to your non-ham relatives. However, certain one-way transmissions are permitted. These include code-practice schedules, bulletins of general amateur radio interest to all hams, emergency drills, and round-table or net operations. (See §12.106.)

The transmission of music is expressly prohibited by the regulations, although tones of short duration may be transmitted for the purpose of testing audio equipment. Also, tone modulation may be used in transmitting code practice over 'phone stations, but not otherwise.

The regulations also prohibit the use of codes and ciphers. This even extends to the use over the air of code groups for code practice transmissions. The usual Q signals and common ham abbreviations may be used, and if you are, for example, talking with a station in France you may use the French language. The Commission has also indicated that it is okay for those who are familiar with the American Morse code to use it on the air, provided that the identifying calls at the beginning and end of transmissions are made with the regular International Morse.

Except for the 11-meter band, duplex operation below 144 Mc. is prohibited. There is a good practical reason for this — to alleviate congestion as much as possible in the more commonly used amateur bands. As another method of assuring more economical use of the frequencies available, the use of other than pure d.c. carriers below 144 Mc. is prohibited.

The rules also require that you have some method for checking the frequency of the emitted signal, this means to be independent of that used to control the transmitter frequency. In other words, if your transmitter is crystal-controlled, you may not merely rely on the calibration of the crystal to insure that you are in the band — you must have some other means. A calibrated receiver will usually suffice if you don't attempt to operate too near the edges of the bands.

Logs

Section 12.136 requires that you keep an adequate log of your amateur operation, available upon request to authorized Commission representatives. The form in which you keep the log is entirely up to you, provided that the necessary information is recorded. The ARRL log book is designed to provide you with not only a neat record of your ham work but also a record which fully complies with the FCC regs. Logs must be retained for at least a year, and so must copies of any messages which you may handle

Civil Defense

To facilitate preparation for civil defense communications, the Federal Communications Commission has established a Radio Amateur Civil Emergency Service. The rules therefor are supplementary to the amateur regulations and appear on pages 74–78 of this manual.

DX Restrictions

United States amateur licensees are warned that international Communications are limited by the following notifications of foreign countries made to the International Telecommunications Union under Article 42 of the Atlantic City (1947) conference.

Austria, Cambodia, Indonesia, Iran, Korea, Laos, Thailand and Viet Nam forbid radio communication between their amateur stations and amateur stations in other countries.

CHAPTER 9

International Regulations

Since it respects no boundary lines, radio by its very nature is international. Thus there must be international agreements on the assignment of frequencies, procedures used in the ship services, and so on. To accomplish this purpose the countries of the world have set up the "International Telecommunications Union," and in its name they regularly hold world-wide and regional conferences to discuss their various radio problems and come to conclusions and agreements.

The domestic regulatory actions of each nation must fit the general pattern established by the world-wide and regional conferences. Therefore the very existence of amateur radio depends upon its inclusion in the allocations tables as one of the services to which frequencies are made available. Especially on the lower-frequency amateur bands, the international allocations are broad, providing for several services in addition to amateurs in "our" bands. Under such joint allocations, each government may assign the band domestically to a particular service, or apportion it between the various services enumerated. In the case of the United States, almost without exception our Government has made available to amateurs every frequency band possible under international regulations, even to the exclusion of other services which are indicated in the international allocation table as eligible to use the band. This is well illustrated, for example, in the 3500–4000 kc. tabulation in the adjoining summary of the allocation table as concerns amateurs resulting from the Atlantic City radio conferences of 1947. It will be seen that the band is available in this hemisphere (Region 2) for either or all the amateur, fixed and mobile services at the discretion of our Government — which has chosen to assign it exclusively to amateurs. In other areas of the world, particularly Europe, the 500 kc. of this band not only is unavailable in its entirety to amateurs, but even those portions for which there are amateur entries are not assigned in most other countries as exclusively amateur.

The agreements among the various nations at international radio conferences include considerable text dealing with various matters in addition to allocations. In the Atlantic City documents, there are two definitions of interest to us:

Amateur Service: A service of self training, intercommunication and technical investigations carried on by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

Amateur Station: A station in the amateur service.

The documents further deal with the amateur service as follows:

ARTICLE 42

Amateur Stations

§ 1. Radiocommunications between amateur stations of different countries shall be forbidden if the administration of one of the countries concerned has notified that it objects to such radiocommunications.

§ 2. (1) When transmissions between amateur stations of different countries are permitted they must be made in plain language and must be limited to messages of a technical nature relating to tests and to remarks of a personal character for which, by reason of their unimportance, recourse to the public telecommunications service is not justified. It is absolutely forbidden for amateur stations to be used for transmitting international communications on behalf of third parties.

(2) The preceding provisions may be modified by special arrangements between the countries concerned.

§ 3. (1) Any person operating the apparatus in an amateur station must have proved that he is able to transmit, and to receive by ear, texts in Morse code signals. Administrations concerned may, however, waive this requirement in the case of stations making use exclusively of frequencies above 1000 (one thousand) Mc/s.

(2) Administrations shall take such measures as they judge necessary to verify the qualifications, from a technical point of view, of any person operating the apparatus of an amateur station.

§ 4. The maximum power of amateur stations shall be fixed by the administrations concerned, having regard to the technical qualifications of the operators and to the conditions under which these stations must work.

§ 5. (1) All the general rules of the Convention and of the present Regulations shall apply to amateur stations. In particular, the transmitting frequency must be as constant and as free from harmonics as the state of technical development for stations of this nature permits.

(2) During the course of their transmissions amateur stations must transmit their call sign at short intervals.

In respect of Section 1, several countries have filed objection to intercommunication between its amateurs and those of other countries. This subject is detailed in an FCC public notice reproduced in Chapter 8.

International Message Traffic

It will have been noted in the international regulation quoted above that when amateur stations of different countries are in contact, the transmissions "must be made in plain language and must be limited to remarks of a technical nature relating to tests and to remarks of a personal character for which, by reason of their

ATLANTIC CITY AMATEUR ALLOCATIONS SUMMARY

Band	*World-wide*	*Region 1 (Europe-Africa)*	*Region 2 (N. & S. America)*	*Region 3 (Rest of World)*
1800–2000 kc.	—	Fixed Mobile	Amateur * Fixed Mobile Radionavigation	Same as Region 2
3500–4000 kc.	—	3500–3800 Amateur Fixed Mobile	3500–4000 Amateur Fixed Mobile	3500–3900 Amateur Fixed Mobile
		3800–3900 Aero mobile Fixed Land mobile		
		3900–3950 Aero mobile		3900–3950 Aero mobile Broadcasting
		3950–4000 Broadcasting Fixed		3950–4000 Broadcasting Fixed
7000–7100	7000–7100 Amateur			
7100–7300 kc.		7100–7150 Amateur Broadcasting	7100–7300 Amateur	7100–7150 Amateur Broadcasting
		7150–7300 Broadcasting		7150–7300 Broadcasting
14,000–14,350 kc.	Amateur			
21,000–21,450 kc.	Amateur			
26,960–27,230 kc.	(In Region 2, Australia, New Zealand, the Union of South Africa and the territory under mandate of Southwest Africa, the amateur service will operate within the band 26,960–27,230 kc.)			
28,000–29,700 kc.	Amateur			
50–54 Mc.	—	Broadcasting	Amateur	Amateur
144–146 Mc.	144–146 Mc. Amateur			
146–148 Mc.		146–148 Aero Mobile	146–148 Amateur	146–148 Amateur
220–225 Mc.		Aero navigation	Amateur	Aero navigation
420–460 Mc.	420–450 Aero navigation Amateur	450–460 Aero navigation Amateur	450–460 Aero navigation Fixed Mobile	450–460 Aero navigation Amateur

* In any particular area the Loran system of radionavigation operates either on 1850 or 1950 kc., the band occupied being 1800–1900 or 1900–2000 kc. Any of the authorized services may employ whichever of these two bands is not required for Loran on condition that they do not cause harmful interference to Loran.

unimportance, recourse to the public telecommunications service is not justified. It is absolutely forbidden for amateur stations to be used for transmitting international communications on behalf of third parties."

In most foreign countries the communications system is a government monopoly. In the interests of revenue and censorship, such foreign governments commonly forbid their amateurs to handle any formal messages or any communications on behalf of third parties, even friendly greetings. The international regulations providing that this arrangement can be modified by special arrangements between nations, the United States Government, at the request of ARRL, has approached the governments of many foreign countries with a proposal to relax this restriction as concerns traffic with U.S. amateurs. Most of the other countries have refused. There are a few exceptions, which we report:

U. S. Possessions: Message traffic of course may be freely handled by American amateurs with the outlying possessions and territories of the United States where amateur stations are licensed by FCC, as well as with the Canal Zone, under the same conditions as domestic traffic is permitted: there must be no pecuniary interest, direct or indirect.

Canada: (1) We may handle messages on behalf of third parties provided that they are of the character that would not normally be sent by any existing means of electrical communication or except for the availability of the amateur stations. (2) We may handle messages from radio stations in isolated points not connected into the regular electrical communication network, such messages to be handed to the local office of the commercial telegraph company for transmission to final destination. (3) In cases of emergency, where the regular communication system is interrupted, amateurs may handle messages of any importance, same to be handed to the nearest point on the commercial telegraph system remaining in operation.

Chile: Same as Canada (1) above.

Peru: Same as Canada (1) above.

Ecuador: Same as Canada (1) above, except that amateurs may handle, in emergencies, traffic relating directly to safety of life or property.

Liberia: Same as Ecuador.

Cuba: Same as Ecuador.

G.I. Stations: The amateur stations operated by U. S. military personnel all over the world are to be regarded as located in little parts of the U. S. A. By common acquiescence, message traffic to and from military personnel is not only permitted but encouraged. However, the orders of the local military commanders commonly confine such traffic strictly to persons in the United States military service or civilians directly associated therewith, to the absolute exclusion of traffic to or from the natives, particularly "enemy" nationals. In some theaters, messages relating to business transactions may not be handled by military-amateur stations and in such a case it is well for the American amateur to make inquiry first whether such a message can be accepted, although there is no bar under our FCC rules to our own handling of such a message to a G.I. station. This applies only to stations where licenses are issued by U.S. authorities.

Australia: Although traffic is normally prohibited, certain official traffic stations of the Wireless Institute of Australia are authorized to handle messages concerning WIA internal administration, and this is deemed to permit the exchange of messages between WIA Headquarters and ARRL Headquarters concerning relations between the two societies, arrangements for contests, etc. Absolutely no third-party personal traffic is permitted, however.

Rest of the World: In general, traffic is prohibited with amateur stations in the rest of the world, not through reluctance on the part of the U. S. Government but because of prohibitions by the other governments concerned. The amateur at the other end is commonly forbidden all traffic handling. Amateurs must abide by this restriction and have no participation in the handling of third-party traffic in such cases.

Special Inter-American Arrangement: One of the various regional radio conferences is known as the Inter-American series, including the American countries in this hemisphere. At the most recent conference, held in Washington, D. C., in 1949, the countries adopted a position looking toward the liberalization of amateur message-handling privileges between the various countries. It is to be noted that liberalized privileges are contemplated only when domestic regulations are not in conflict, which unfortunately they often are. At the moment, message-handling privileges between amateurs in the Americas are confined to those countries, listed above, with which there are special arrangements.

Amateur Third-Party Messages

The American countries, with the purpose of further improving their close and friendly relations, and when their international legislation permits, agree to authorize amateur stations in their respective countries and possessions to exchange internationally messages emanating from third parties; provided, however, that such messages shall be of such character that would not normally be sent by any other existing means of telecommunications, and on which no compensation may be directly or indirectly paid.

CHAPTER 10

U. S. Regulations

Part I—Extracts from the Communications Law

The complete text of the Communications Act of 1934 would occupy many pages. Only those parts most applicable to amateur radio station licensing and regulation in this country (with which every amateur should be familiar) are given. Note particularly Secs. 324, 325, and 605 and the penalties provided in Secs. 501 and 502.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Section 1. For the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nation-wide and world-wide wire and radio communication service with adequate facilities at reasonable charges, for the purpose of the national defense, for the purpose of promoting safety of life and property through the use of wire and radio communication, and for the purpose of securing a more effective execution of this policy by centralizing authority heretofore granted by law to several agencies and by granting additional authority with respect to interstate and foreign commerce in wire and radio communication, there is hereby created a commission to be known as the "Federal Communications Commission," which shall be constituted as hereinafter provided, and which shall execute and enforce the provisions of this Act.

Sec. 2. (a) The provisions of this Act shall apply to all interstate and foreign communication by wire or radio and all interstate and foreign transmission of energy by radio, which originates and/or is received within the United States, and to all persons engaged within the United States in such communication or such transmission of energy by radio, and to the licensing and regulating of all radio stations as hereinafter provided; but it shall not apply to persons engaged in wire or radio communication or transmission in the Philippine Islands or the Canal Zone, or to wire or radio communication or transmission wholly within the Philippine Islands or the Canal Zone. . . .

Sec. 4. (a) The Federal Communications Commission (in this Act referred to as the "Commission") shall be composed of seven commissioners appointed by the President, by and with the advice and consent of the Senate, one of whom the President shall designate as chairman.

Section 301. It is the purpose of this Act, among other things, to maintain the control of the United States over all the channels of interstate and foreign radio transmission; and to provide for the use of such channels, but not the ownership thereof, by persons for limited periods of time, under licenses granted by Federal authority, and no such license shall be construed to create any right, beyond the terms, conditions, and periods of the license. No person shall use or operate any apparatus for the transmission of energy or communications or signals by radio . . . except under and in accordance with this Act and with a license in that behalf granted under the provisions of this Act.

Sec. 303. Except as otherwise provided in this Act, the Commission from time to time, as public convenience, interest, or necessity requires, shall—

(a) Classify radio stations;

(b) Prescribe the nature of the service to be rendered. . . .

(c) Assign frequencies. . . .

(d) Determine the location of stations. . . .

(e) Regulate the kind of apparatus to be used with respect to its external effects and the purity and sharpness of the emissions from each station and from the apparatus therein;

(f) Make such regulations not inconsistent with law as it may deem necessary to prevent interference between stations and to carry out the provisions of this Act. . . .

(g) Study new uses for radio, provide for experimental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest; . . .

(j) Have authority to make general rules and regulations requiring stations to keep such records as it may deem desirable. . . .

(l) Have authority to prescribe the qualifications of station operators. . . .

(m) (1) Have authority to suspend the license of any operator upon proof sufficient to satisfy the Commission that the licensee—(A) has violated any provision of any Act, treaty, or convention binding on the United States, which the Commission is authorized to administer, or any regulation made by the Commission under any such Act, treaty, or convention; or (B) has failed to carry out a lawful order of the master or person lawfully in charge of the ships or aircraft on which he is employed; or (C) has willfully damaged or permitted radio apparatus or installations to be damaged; or (D) has transmitted superfluous radio communications or signals or communications containing profane or obscene words, language, or meaning, or has knowingly transmitted—

(1) false or deceptive signals or communications; or

(2) a call signal or letter which has not been assigned by proper authority to the station he is operating; or (E) has willfully or maliciously interfered with any other radio communications or signals; or (F) has obtained or attempted to obtain, or has assisted another to obtain or attempt to obtain, an operator's license by fraudulent means.

(2) No order of suspension of any operator's license shall take effect until fifteen days' notice in writing thereof, stating the cause for the proposed suspension, has been given to the operator licensee who may make written application to the Commission at any time within said fifteen days for a hearing upon such order. . . .

(n) Have authority to inspect all radio installations. . . .

(o) Have authority to designate call letters of all stations.

(p) Have authority to cause to be published such call letters. . . .

(q) Have authority to require the painting and/or illumination of radio towers if and when in its judgment such towers constitute, or there is a reasonable possibility that they may constitute, a menace to air navigation.

(r) Make rules and regulations necessary to carry out the provisions of this Act, or any international radio or wire communications treaty or convention. . . .

Sec. 309. (a) If upon examination of any application for a station license or for the renewal or modification of a station license the Commission shall determine that public interest, convenience, or necessity would be served by the granting thereof, it shall authorize the issuance, renewal, or modification thereof in accordance with said finding. . . .

Sec. 318. The actual operation of all transmitting apparatus in any radio station for which a station license is required by this Act shall be carried on only by a person holding an operator's license issued hereunder. No person shall operate any such apparatus in such station except under and in accordance with an operator's license issued to him by the Commission. . . .

Sec. 321. . . . (b) All radio stations, including Government stations and stations on board foreign vessels when within the territorial waters of the United States, shall give absolute priority to ships in distress.

Sec. 324. In all circumstances, except in case of radio communications or signals relating to vessels in distress, all radio stations, including those owned and operated by the United States, shall use the minimum amount of power necessary to carry out the communication desired.

Sec. 325. (a) No person within the jurisdiction of the United States shall knowingly utter or transmit, or cause to be uttered or transmitted, any false or fraudulent signal of distress, or communication relating thereto, nor shall any broadcasting station rebroadcast the program or any part thereof of another broadcasting station without the express authority of the originating station.

Sec. 501. Any person who willfully and knowingly does or causes or suffers to be done any act, matter, or thing, in this Act prohibited or declared to be unlawful, or who willfully and knowingly omits or fails to do any act, matter, or thing in this Act required to be done, or willfully and knowingly causes or suffers such omission or failure, shall, upon conviction thereof, be punished for such offense, for which no penalty (other than a forfeiture) is provided herein, by a fine of not more than $10,000 or by imprisonment for a term of not more than two years, or both.

Sec. 502. Any person who willfully and knowingly violates any rule, regulation, restriction, or condition made or imposed by the Commission under authority of this Act, or any rule, regulation, restriction, or condition made or imposed by any international radio or wire communications treaty or convention, or regulations annexed thereto, to which the United States is or may hereafter become a party, shall, in addition to any other penalties provided by law, be punished, upon conviction thereof, by a fine of not more than $500 for each day during which such offense occurs.

Sec. 605. No person receiving or assisting in receiving, or transmitting, or assisting in transmitting, any interstate or foreign communication by wire or radio shall divulge or publish the existence, contents, substance, purport, effect or meaning thereof, except through authorized channels of transmission or reception, to any person other than the addressee, his agent, or attorney, or to a person employed or authorized to forward such communication to its destination, or to proper accounting or distributing officers of the various communicating centers over which the communication may be passed, or to the master of a ship under whom he is serving, or in response to a subpoena issued by a court of competent jurisdiction, or on demand of other lawful authority; and no person not being authorized by the sender shall intercept any communication and divulge or publish the existence, contents, substance, purport, effect, or meaning of such intercepted communication to any person; and no person not being entitled thereto shall receive or assist in receiving any interstate or foreign communication by wire or radio and use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto; and no person having received such intercepted communication or having become acquainted with the contents, substance, purport, effect, or meaning of the same or any part thereof, knowing that such information was so obtained, shall divulge or publish the existence, contents, substance, purport, effect, or meaning of the same or any part thereof, or use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto: *Provided*, That this section shall not apply to the receiving, divulging, publishing, or utilizing the contents of any radio communication broadcast, or transmitted by amateurs or others for the use of the general public, or relating to ships in distress.

Sec. 606. . . . (c) Upon proclamation by the President that there exists war or a threat of war or a state of public peril or disaster or other national emergency, or in order to preserve the neutrality of the United States, the President may suspend or amend, for such time as he may see fit, the rules and regulations applicable to any or all stations within the jurisdiction of the United States as prescribed by the Commission, and may cause the closing of any station for radio communication and the removal therefrom of its apparatus and equipment, or he may authorize the use or control of any such station and/or its apparatus and equipment by any department of the Government under such regulations as he may prescribe, upon just compensation to the owners.

Part II – United States Amateur Regulations

Pursuant to the basic communications law, general regulations for amateurs have been drafted by the Federal Communications Commission.

Every amateur should be *thoroughly familiar* with these regulations and their effect, although, of course, it is not necessary to know the exact wording from memory.

RULES GOVERNING AMATEUR RADIO SERVICE

§ 12.0. *Basis and Purpose.* The rules and regulations in this part are designed to provide an Amateur Radio Service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications. (b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

DEFINITIONS

§ 12.1. *Amateur Service.* The term "amateur service" means a radio service carried on by amateur stations.

§ 12.2. *Amateur operator.* The term "amateur operator" means a person interested in radio technique solely with a personal aim and without pecuniary interest, holding a valid license issued by the Federal Communications Commission authorizing him to operate licensed amateur stations.

§ 12.3. *Amateur station.* The term "amateur station" means a station used by an amateur operator, and it embraces all radio transmitting apparatus at a particular location used for amateur service and operated under a single instrument of authorization.

§ 12.4. *Amateur portable station.* The term "amateur portable station" means an amateur station that is so constructed that it may conveniently be moved about from place to place for communication, but which is not operated while in motion.

§ 12.5. *Amateur mobile station.* The term "amateur mobile station" means an amateur station that is so constructed that it may conveniently be transferred to or from a mobile unit or from one such unit to another, and is ordinarily used while such mobile unit is in motion.

§ 12.6. *Amateur radio communication.* The term "amateur radio communication" means radio communication between amateur stations solely with a personal aim and without pecuniary interest.

§ 12.7. *Remote control.* The term "remote control" as applied to the Amateur Radio Service, means control of transmitting equipment of an amateur station from an operating position other than one at which the transmitter is in view and immediately accessible; except that, direct mechanical control or direct electrical control by wired connections of an amateur transmitter, from a point located on board any aircraft, vessel or vehicle on which such transmitter is located shall not be considered remote control within the meaning of this definition.

§ 12.9. *Antenna structure defined.* The term "antenna structure" includes the radiating system and its supporting structures.

§ 12.10. *Aircraft landing area defined.* An aircraft landing area means any locality, either on land or water, including airports and intermediate landing fields, which is used, or approved for use, for landing and take-off of aircraft whether or not facilities are provided for the shelter, servicing, or repair of aircraft, or for the receiving or discharging of passengers or cargo.

AMATEUR OPERATORS

LICENSES — PRIVILEGES

§ 12.20. *Classes of Amateur Operator Licenses.*

Amateur Extra Class.
Advanced Class . . . . (Previously Class A)
General Class . . . . (Previously Class B)
Conditional Class . . . . (Previously Class C)
Technician Class.
Novice Class.

§ 12.21. *Eligibility for license.* Persons are eligible to apply for the various classes of amateur operator licenses as follows:

(a) *Amateur Extra Class.* Any citizen of the United States who either (1) at any time prior to receipt of his application by the Commission has held for a period of two years or more a valid amateur operator license issued by the Federal Communications Commission, excluding licenses of the Novice and Technician Classes, or (2) submits evidence of having held a valid amateur radio station or operator license issued by any agency of the United States Government during or prior to April, 1917.

(b) *Advanced Class.* New Advanced Class amateur operator licenses will not be issued: however; Advanced Class (or Class A) licenses may continue to be renewed as set forth in Section 12.27.

(c) *General Class.* Any citizen of the United States.

(d) *Conditional Class.* Any citizen of the United States whose actual residence and amateur station location are more than 75 miles air line distant from the nearest location at which examinations are held at intervals of not more than 3 months for General Class amateur operator license; or who is shown by physician's certificate to be unable to appear for examination because of protracted disability; or who is shown by certificate of the commanding officer to be in the armed forces of the United States at an Army, Navy, Air Force or Coast Guard station and, for that reason, to be unable to appear for examination at the time and place designated by the Commission.

(e) *Technician Class.* Any citizen of the United States.

(f) *Novice Class.* Any citizen of the United States except a former holder of an amateur license of any class issued by any agency of the United States government, military or civilian.

§ 12.22. *Application for amateur operator license.* The application for any new amateur operator license, including application for any change in operating privileges, shall be submitted in person or by mail to the district field office of the Commission at which the applicant desires his application to be considered and acted upon, which office will make the final arrangements for conducting any required examination. If the application is for a license which is obtained upon successful completion of an examination by volunteer examiners under the special provisions of Section 12.44(c), the application shall be submitted to the district field office which supplied the examination material. Applications for renewal or modification of license, or for duplicate license, when no change in operating privileges is involved, shall be filed directly with the Commission at its Washington 25, D. C. office.

§ 12.23. *Classes and privileges of amateur operator licenses.*

(a) *Amateur Extra Class.* All authorized amateur privileges including such additional privileges in both communication and technical phases of the art which the Commission may consider as appropriately limited to holders of this class of license.

(b) *Advanced Class.* All amateur privileges except those which may be reserved to holders of the Amateur Extra Class license.

(c) *General and Conditional Classes.* All authorized amateur privileges.

(d) *Technician Class.* All authorized amateur privileges in the amateur frequency bands above 220 megacycles.

(e) *Novice Class.* Those amateur privileges as designated and limited as follows:

(1) The d.c. plate power input to the vacuum tube or tubes supplying power to the antenna shall not exceed 75 watts.

(2) Only the following frequency bands and types of emission may be used, and the emissions of the transmitter must be crystal-controlled:

(i) 3700 to 3750 Kc., radiotelegraphy using only type A1 emission in accordance with the geographical restrictions set forth in Section 12.111 of this Part.

(ii) 7175 to 7200 kc., radiotelegraphy using only type A1 emission.

(iii) 21.10 to 21.25 Mc., radiotelegraphy using only type A-1 emission.

(iv) 145 to 147 Mc., radiotelegraphy or radiotelephony using any type of emission except pulsed emissions and type B emission.

§ 12.25. *Availability of operator license.* The original operator license of each operator shall be kept in the personal possession of the operator while operating an amateur station. When operating an amateur station at a fixed location, however, the license may be posted in a conspicuous place in the room occupied by the operator. The license shall be available for inspection by any authorized government official whenever the operator is operating an amateur station and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost, or destroyed, and application has been made for a duplicate license in accordance with section 12.26. No recognition shall be accorded to any photocopy of an operator license; however, nothing in this section shall be construed to prohibit the photocopying for other purposes of any amateur radio operator license.

§ 12.26. *Duplicate license.* Any licensee applying for a duplicate license to replace an original which has been lost, mutilated, or destroyed, shall submit with the application the mutilated license or a statement setting forth the facts regarding the manner in which the original license was lost or destroyed. If, subsequent to receipt by the licensee of the duplicate license, the original license is found, either the duplicate or the original license shall be returned immediately to the Commission.

§ 12.27. *Renewal of amateur operator license.*[1] (a) An amateur operator license, except the Novice Class, may be renewed upon proper application in which it is stated that the applicant has lawfully accumulated, at an amateur station licensed by the Commission, a minimum total of either 2 hours operating time during the last three months or 5 hours operating time during the last 12 months of the license term. Such operating time, for the purpose of renewal, shall be counted as the total of all that time between the entries in the station log showing the beginning and end of transmissions as required in Section 12.136(a), both during single transmissions and during a sequence of transmissions. The application shall, in addition to the foregoing, include a statement that the applicant can send by hand key, i.e., straight key or any other type of hand operated key such as a semi-automatic or electronic key, and receive by ear, in plain language, messages in the International Morse Code at a speed of not less than that which is required in qualifying for an original license of the class being renewed.

(b) The Novice Class license will not be renewed.

(c) The applicant shall qualify for a new license by examination if the requirements of this section are not fulfilled.

(d) A renewal application which includes a modification (change of address or operator class) shall be submitted on FCC Form 610, and shall be accompanied by the applicant's amateur operator license, and also by his amateur station license if he holds one.

(e) Application for renewal of an amateur operator license without modification shall be submitted on FCC Form 405-A. Applications on Form 405-A should not be accompanied by the applicant's license. Unless otherwise directed by the Commission, each application for renewal of license shall be filed during the last 120 days of the license term or within a period of grace of one year after the expiration date of such license. During this one year period of grace an expired license is not valid. A renewed license issued upon the basis of an application filed during the grace period will be dated currently and will not be back-dated to the date of expiration of the license being renewed. In any case in which the licensee has, in accordance with the Commission's rules made timely and sufficient application for renewal of license, no license with reference to any activity of a continuing nature shall expire until such application shall have been finally determined.

(f) Renewal applications shall be governed by applicable rules in force on the date when application is filed.

§ 12.28. *Who may operate an amateur station.* An amateur radio station may be operated only by a person holding a valid amateur operator license. Such station may be operated by the licensee only in the manner and to the extent provided in his amateur operator license. Persons other than the station licensee, when operating such station, may operate it only to the extent and in the manner authorized to the licensee of the station and not exceeding the operating authority of such person's own amateur operator license. When an amateur station is used for telephony, the station licensee may permit any person to transmit by voice, provided during such transmission call signs are announced as prescribed by Section 12.82 and a duly licensed amateur operator maintains actual control over the emissions, including turning the carrier on and off for each transmission and signing the station off after communication with each station has been completed.

§ 12.29. *License term.* Amateur operator licenses are normally valid for a period of 5 years from the date of issuance of a new or renewed license, except the Novice Class which is normally valid for a period of 1 year from the date of issuance. Modified and duplicate licenses shall bear the same date of expiration as the licenses for which they are modifications or duplicates.

§ 12.30. *Order of Suspension.* No order of suspension of any operator's license shall take effect until 15 days' notice in writing thereof, stating the cause for the proposed suspension, has been given to the operator licensee who may make written application to the Commission at any time within said 15 days for a hearing upon such order. The notice to the operator licensee shall not be effective until actually received by him, and from that time he shall have 15 days in which to mail the said application. In the event that physical conditions prevent mailing of the application at the expiration of the 15-day period, the application shall then be mailed as soon as possible thereafter, accompanied by a satisfactory explanation of the delay. Upon receipt by the Commission of such application for hearing, said order of suspension shall be held in abeyance until the conclusion of the hearing which shall be conducted under such rules as the Commission shall deem appropriate. Upon the conclusion of said hearing the Commission may affirm, modify, or revoke said order of suspension.

§ 12.31. *Proceedings.* Proceedings for the suspension of an operator's license shall in all cases be initiated by the entry of an order of suspension. Respondent will be given notice thereof together with notice of his right to be heard and to contest the proceeding. The effective date of the suspension will not be specified in the original order but will be fixed by subsequent motion of the Commission in accordance with the conditions specified above. Notice of the effective date of suspension will be given respondent, who shall send his operator license to the office of the Commission in Washington, D. C., on or before the said effective date, or, if the effective date has passed at the time notice is received, the license shall be sent to the Commission forthwith.

EXAMINATIONS

§ 12.41. *When examination is required.* Examination is required for the issuance of a new amateur operator license, and for a change in class of operating privileges. Credit may be given, however, for certain elements of examination as provided in Section 12.46.

§ 12.42. *Examination elements.* Examinations for amateur operator privileges will comprise one or more of the following examination elements:

Element 1(A) *Beginner's code test.* Code test at five (5) w.p.m.

Element 1(B) *General code test.* Code test at thirteen (13) w.p.m.

Element 1(C) *Expert's code test.* Code test at twenty (20) w.p.m.

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[1] Until further order of the Commission, the showing that the applicant actually operated an amateur radio station or stations for the periods of time specified in §12.27 will not be required in cases where it is shown that the applicant was unable to conduct such operation because he was on active duty in the armed forces of the United States or was duly enrolled as an employee of an agency of the Federal Government and in the course of such employment was on duty in a foreign country continuously during the last year of the license term: Provided, That any such employee of the Federal Government shall submit with his application for renewal of license a statement signed by his agency head, or the chief of the Bureau or Division in which he is employed attesting to such employment.

Element 2 — *Basic amateur practice.* Amateur radio operation and apparatus, including radiotelephone and radiotelegraph.

Element 3(A) — *Basic law.* Rules and regulations essential to beginners' operation, including sufficient elementary radio theory for the understanding of those rules.

Element 3(B) — *General regulations.* Provisions of treaties, statutes, and rules and regulations affecting all amateur stations and operators.

Element 4(B) — *Advanced amateur practice.* Advanced radio theory and operation as applicable to modern amateur techniques, including, but not limited to, radiotelephony, radiotelegraphy, and transmissions of energy for measurements and observations applied to propagation, for the radio control of remote objects and for similar experimental purposes.

§ 12.43. *Examination requirements.* Applicants for original licenses will be required to pass examinations as follows:

(a) *Amateur Extra class:* Element 1(C), 2, 3(B) and 4(B).
(b) *General class:* Elements 1(B), 2 and 3(B).
(c) *Conditional class:* Elements 1(B), 2 and 3(B).
(d) *Technician class:* Elements 1(A), 2 and 3(B).
(e) *Novice class:* Elements 1(A) and 3(A).

§ 12.44. *Manner of conducting examinations.*

(a) The examinations for Extra and General Classes of amateur operator licenses will be conducted by an authorized Commission employee or representative at locations and at times specified by the Commission. The examinations for Conditional Class, as well as Technician and Novice Class licenses, will be conducted in accordance with the provisions of paragraph (c) of this Section. The examinations for Conditional Class will be available only under one or more of the following conditions:

> (1) If the applicant's actual residence and proposed amateur station location are more than 75 miles airline distance from the nearest location at which examinations are conducted by an authorized Commission employee or representative at intervals of not more than 3 months for amateur operator licenses; or (2) If the applicant is shown by physician's certificate to be unable to appear for examination because of protracted disability; or (3) If the applicant is shown by certificate of the commanding officer to be in the armed forces of the United States at an Army, Navy, Air Force, or Coast Guard station and, for that reason, to be unable to appear for examination at the time and place designated by the Commission.

(b) A holder of a Conditional, Technician or Novice Class license obtained on the basis of an examination under the provisions of paragraph (c) of this section is not required to be reexamined when changing residence and station location to within a regular examination area, nor when a new examination location is established within 75 miles of such licensee's residence and station location.

(c) Each examination for Conditional Class license, or for Technician, or Novice Class license, shall be conducted and supervised by not more than two volunteer examiners, whom the Commission may designate or permit the applicant to select (not more than one examiner for the code test and not more than one examiner for the complete written examination). In the event the examiner for the code test is selected by the applicant, such examiner shall be the holder of an Extra Class, Advanced Class, or General Class amateur operator license or shall have held, within the 5 years prior to the date of the examination, a commercial radiotelegraph operator license issued by the Commission or within that time shall have been employed in the service of the United States as the operator of a manually operated radiotelegraph station. The examiner for the written test shall be at least 21 years of age. Examinations for Conditional Class will be available only under special conditions set forth in paragraphs (a) (1), (2), or (3) or this section.

§ 12.45. *Additional examination for holders of Conditional Class Operator licenses.* (a) The Commission may require a licensee holding a Conditional Class of operator license to appear for a General Class license examination at a location designated by the Commission. If the licensee fails to appear for the General Class examination when directed to do so, or fails to pass such examination, the Conditional Class operator license previously issued shall be subject to cancellation and, upon cancellation, a new license will not be issued for the Conditional Class privileges.

(b) Whenever the holder of a Conditional Class amateur operator license is required by the Commission to restrict the operation of his amateur station in accordance with the provisions of Sections 12.152, 12.153 and 12.154, the necessity for those restrictions shall be considered sufficient grounds to require the holder of the Conditional Class license to appear for the General Class examination.

§ 12.46. *Examination credit.* (a) An applicant for a higher class of amateur operator license who holds a valid amateur operator license issued upon the basis of an examination by the Commission will be required to pass only those elements of the higher class examination that were not included in the examination for the amateur license held when such application was filed. However, credit will not be allowed for licenses issued on the basis of an examination given under the provisions of Section 12.44(c).

(b) An applicant for any class of amateur operator license, except for the Extra Class, will be given credit for the telegraph code element if within 5 years prior to the receipt of his application by the Commission he held a commercial radiotelegraph first or second class operator license issued by the Federal Communications Commission.

(c) An applicant for Amateur Extra Class operator license will be given credit for examination elements 1(C) and 4(B) if he so requests and submits evidence of having held a valid amateur radio station or operator license issued by any agency of the United States Government during or prior to April, 1917, and qualifies for or currently holds a valid amateur operator license of the General or Advanced Class.

(d) No examination credit, except as herein provided, shall be allowed on the basis of holding or having held any amateur or commercial operator license.

§ 12.47. *Examination procedure.* All written portions of the examinations for amateur operator privileges shall be completed by the applicant in legible handwriting or hand printing, and diagrams shall be drawn by hand, by means of either pen and ink or pencil. Whenever the applicant's signature is required, his normal signature shall be used. Applicants unable to comply with these requirements, because of physical disability, may dictate their answers to the examination questions and the receiving code test and if unable to draw required diagrams, may dictate a detailed description essentially equivalent. If the examination or any part thereof is dictated, the examiner shall certify the nature of the applicant's disability and the name and address of the person(s) taking and transcribing the applicant's dictation.

§ 12.48. *Grading.* (a) Code tests for sending and receiving are graded separately. Failure to pass the required code test for either sending or receiving will terminate the examination.

(b) Seventy-four percent is the passing grade for written examinations. For the purpose of grading, all elements, other than element 4(B), required in qualifying for a particular license will be considered a single examination, and element 4(B), will be considered as a separate examination.

§ 12.49. *Eligibility for re-examination.* An applicant who fails examination for amateur operator privileges may not take another examination for such privileges within 30 days, except that this limitation shall not apply to an examination, for a General Class license following an examination for a Conditional Class license.

§ 12.50. *Code test procedure.* The code test required of an applicant for amateur radio operator license, in accordance with the provisions of Sections 12.42 and 12.43, shall determine the applicant's ability to transmit by hand key (straight key, or if supplied by the applicant, any other type of hand operated key such as a semi-automatic or electronic key) and to receive by ear, in plain language, messages in the International Morse Code at not less than the prescribed speed, free from omission or other error for a continuous period of at least 1 minute during a test period of 5 minutes, counting five characters to the word, each numeral or punctuation mark counting as two characters.

AMATEUR RADIO STATIONS

LICENSES

§ 12.60. *Limitation on antenna structures.* — (a) No new antenna structure shall be erected for use by any station in the Amateur Radio Service, and no change shall be made in any existing antenna structure used or intended to be used by any station in the Amateur Radio Service so as to increase its over-all height above ground level, without prior approval by the Commission, in any case when either (1) the antenna structure proposed to be erected will exceed an over-all height of 170 feet above ground level, except in the case where the antenna is mounted on top of an existing man-made structure and does not increase the over-all height of such man-made structure by more than 20 feet, or (2) the antenna structure proposed to be erected will exceed an over-all height of one foot above the established elevation of any landing area for each 200 feet of distance, or fraction thereof, from the nearest boundary of such landing area, except in the case where the antenna structure does not exceed 20 feet above the ground or is mounted on top of an existing man-made structure or natural formation and does not increase the over-all height of such man-made structure or natural formation by more than 20 feet as a result of such mounting. Application for Commission approval, when such approval is required, shall be submitted on FCC Form No. 401-A, in triplicate.

(b) In cases where FCC Form No. 401-A is required to be filed, further details as to whether an aeronautical study and/or obstruction marking may be required, and specifications for obstruction marking when required, may be obtained from Part 17 of this Chapter, "Rules Concerning the Construction, Marking, and Lighting of Antenna Towers and Supporting Structures". Information regarding requirements as to inspection of obstruction marking, recording of information regarding such inspection, and maintenance of antenna structures is also contained in Part 17.

§ 12.61. *Eligibility for amateur station license.* A license for an amateur station will be issued in response to proper application therefor to a licensed amateur operator who has made a satisfactory showing of control of the transmitting station for which license is desired and of control of the specific premises upon which all of the station apparatus is to be located, at a designated fixed location. An amateur station license may be issued to an individual, not a licensed amateur operator (other than an alien or a representative of an alien or of a foreign government), who is in charge of a proposed amateur station located in approved public quarters and established for training purposes in connection with the armed forces of the United States, but not operated by the United States Government.

§ 12.62. *Eligibility of corporations or organizations to hold license.* An amateur station license will not be issued to a school, company, corporation, association, or other organization, nor for its use except that in the case of a bona fide amateur radio organization or society a station license may be issued to a licensed amateur operator, other than the holder of a Novice Class license, as trustee for such society.

§ 12.63. *Application for amateur station license.* (a) Each application for an amateur station license shall comply with the Commission's Rules and Regulations and shall be made in writing, subscribed and verified on FCC Form No. 610 (application for amateur operator and/or station license). FCC Form No. 602 should be used where the applicant is in charge of a proposed amateur station located in approved public quarters and established for training purposes in connection with the armed forces of the United States, but not operated by the United States Government.

(b) One application and all papers incorporated therein and made a part thereof shall be submitted for each amateur station license. If the application is for station license only, it shall be filed directly with the Commission at its Washington 25, D. C. office. If the application also contains application for any class of amateur operator license, it shall be filed in accordance with the provisions of §12.22.

§ 12.64. *Location of Station.* (a) Every amateur station shall have a fixed transmitter location. Only one fixed transmitter location will be authorized and will be designated on the license for each amateur station, except that when remote control is authorized, the location of the remote control position as well as the location of the remotely-controlled transmitter shall be considered as fixed transmitter locations and will be so designated on the station license. Unless remote control of the transmitting apparatus is authorized, such apparatus shall be operated only by a duly licensed amateur radio operator present at the location of such apparatus.

(b) Authority for operation of an amateur station with the licensed operator on duty at a specific remote control point in lieu of the remote transmitter location may be granted upon filing an application for a modified station license on FCC Form No. 610 or FCC Form No. 602, as appropriate, and provided that the following conditions are met: (1) The remote control point as well as the remotely-controlled transmitter, shall be located on premises controlled by the licensee. (2) The remotely-controlled transmitter shall be so installed and protected that it is inaccessible to other than duly authorized persons. (3) In addition to the requirements of section 12.68 a photocopy of the amateur station license shall be posted in a conspicuous place at the location of the remotely-controlled transmitter. (4) Means shall be provided at the control point to permit the continuous monitoring of the emissions of the remotely-controlled transmitter, and it shall be continuously monitored when in operation. (5) Means shall be provided at the remote control point immediately to suspend the radiation of the transmitter when there is any deviation from the terms of the station license or from the Rules Governing Amateur Radio Service. (6) In the event that operation of an amateur transmitter from a remote control point by radio is desired, an application for a modified station license on FCC Form No. 610 or FCC Form No. 602, as appropriate, should be submitted with a letter requesting authority to operate in such a manner stating that the controlling transmitter at the remote location will operate within amateur frequency bands 420 megacycles or higher and that there will be full compliance with section 12.64(b), subparagraphs (1) through (5). Supplemental statements and diagrams should accompany the application and show how radio remote control will be accomplished and what means will be employed to prevent unauthorized operation of the transmitter by signals other than those from the controlling unit. There should be included complete data on control channels, relays and functions of each, dirctional antenna design for the transmitter and receiver in the control circuit, and means employed for turning on and off the main transmitter from the remote control location.

(c) An amateur transmitter may be operated from a remote control point in lieu of the remote transmitter location without special authorization by the Commission when there is direct mechanical control or direct electrical control by wired connections of the transmitter from a point located in the same or closely adjoining building or structure provided there is full compliance with the conditions set forth in the section 12.64 (b), subparagraphs (1) through (5).

§ 12.65. *License Period.* The license for an amateur station is normally valid for a period of 5 years from the date of issuance of a new or renewed license, except that an amateur station license issued to the holder of a Novice Class amateur operator license is normally valid for a period of 1 year from the date of issuance. Any modified or duplicate license shall bear the same expiration date as the license for which it is a modification or duplicate.

§ 12.66. *Authorized apparatus.* An amateur station license authorizes the use under control of the licensee of all transmitting apparatus at the fixed location specified in the station license which is operated on any frequency or frequencies allocated to the amateur service, and in addition authorizes the use, under control of the licensee, of portable and mobile transmitting apparatus operated at other locations.

§ 12.67. *Renewal of amateur station license.*

(a) Application for renewal of station license without modification shall be submitted on FCC Form 405-A. Applications on Form 405-A should not be accompanied by the applicant's license. Unless otherwise directed by the Commission, each application for renewal of license shall be filed during the last 120 days of the license term or within a period of grace of one year after the expiration date of such license. During this one year period of grace an expired license is not valid. A renewed license issued upon the basis of an application filed during the grace period will be dated currently and will not be backdated to the date of expiration of the license being renewed. This one year period of grace shall apply only to licenses expiring on or after January 1, 1951. In any case in which the licensee has, in accordance with the Commission's rules made timely and sufficient application for renewal of license, no license with reference to any activity of a continuing nature shall expire until such application shall have been finally determined.

(b) A renewal application which includes a modification (change of address) shall be submitted on FCC Form 610 and shall be accompanied by the applicant's amateur station license, and also by his amateur operator license if he holds one.

(c) Renewal applications shall be governed by applicable rules in force on the date when application is filed.

§ 12.68. *Availability of station license.* The original license of each amateur station or a photocopy thereof shall be posted in a conspicuous place in the room occupied by the licensed operator while the station is being operated at a fixed location or shall be kept in his personal possession. When the station is operated at other than a fixed location, the original station license or a photocopy thereof shall be kept in the personal possession of the station licensee (or a licensed representative) who shall be present at the station while it is being operated as a portable or mobile station. The original station license shall be available for inspection by any authorized government official at all times while the station is being operated and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost, or destroyed, and application has been made for a duplicate license in accordance with section 12.26.

§ 12.69 *Revocation of station license and issuance of cease and desist orders.*

(a) Whenever it appears that a station license should be revoked for any of the reasons set forth in section 312 (a) of the Communications Act of 1934, as amended, or a cease and desist order should be issued for any of the reasons specified in section 312 (b) of the act, the Commission will issue an order directing the licensee to show cause why an order of revocation or a cease and desist order, as the case may be, should not be issued.

(b) Any order to show cause issued in accordance with paragraph (a) of this section will contain a statement of matters with respect to which the Commission is inquiring and will call upon the licensee to appear before the Commission at a time and place stated in the order, but in no event less than thirty (30) days after the receipt of such order, and give evidence upon the matter specified therein; except that where safety of life or property is involved, the Commission may provide in the order for a shorter period.

(c) In order to avail himself of the opportunity to appear before the Commission at the time and place stated in the show cause order to give evidence upon the mater specified therein, the licensee, in person or by his attorney, shall, within 30 days of the receipt of the order, or such shorter period as may be specified therein if the safety of life and property is involved, file with the Commission, in triplicate, a written appearance stating that he will appear and present evidence on the matter specified in the order.

(d) The hearing on the matter specified in the order to show cause, and the practice and procedure in connection therewith, shall accord with the provisions of Subparts F and G of Part 1 of the Commission's Rules of Practice and Procedure, except that in all such hearings the burden of proof shall be upon the Commission.

(e) If the licensee does not desire to appear before the Commission and give evidence upon the matter specified in the show cause order, he shall, within 30 days of the receipt of the order, or such shorter period as may be specified therein if the safety of life or property is involved, file with the Commission, in triplicate, a written waiver of hearing. Such waiver, which shall include the name of the licensee to whom the show cause order was addressed, the call letters of his station, if any, and the docket number of the proceeding, may be accompanied by a statement of reasons why the licensee believes that the order of revocation or a cease and desist order, as the case may be, should not be issued.

(f) If the licensee fails timely to respond to an order to show cause or fails to appear at a hearing, such failure will be deemed a waiver of hearing.

(g) If the licensee waives a hearing in accordance with the provisions of paragraph (e) of this section and fails to submit a statement therewith showing why he believes an order of revocation or a cease and desist order should not be issued, or if he is deemed to waive a hearing in accordance with the provisions of paragraph (f) of this section, the allegations specified in the order to show cause will be deemed to be admitted and a decision will be issued by the Commission invoking the sanction specified in the order to show cause. If a hearing is waived pursuant to paragraph (e) of this section but a written statement as to why an order of revocation or cease and desist order should not be issued is submitted, the Commission will, on the basis of the facts before it as supplemented by such written statement, issue a decision stating its reasons for invoking the sanction specified in the order to show cause or for dismissing the proceeding, as the case may be: *Provided,* That where the written statement contains factual allegations contrary to those upon which the show cause order was based, the Commission may call upon the submitting party to furnish additional information under oath, or, if necessary, designate the proceeding for oral hearing. The decisions of the Commission referred to in this paragraph shall have the same effect as an initial decision, and the procedure to be followed thereafter shall be the same as in the case of an initial decision issued in the course of the regular hearing procedure (see §§ 1.853–1.857 of Part 1, Rules of Practice and Procedure).

(h) Any order of revocation or cease and desist order issued pursuant to this section shall include a statement of the findings and the grounds and reasons therefor and specify the effective date of the order, and shall be served on said licensee.

§ 12.70. *Modification of station license.* (a) Whenever the Commission shall determine that public interest, convenience, and necessity would be served, or any treaty ratified by the United States will be more fully complied with, by the modification of any radio station license either for a limited time, or for the duration of the term thereof, it shall issue an order for such licensee to show cause why such license should not be modified.

(b) Such order to show cause shall contain a statement of the grounds and reasons for such proposed modification, and shall specify wherein the said license is required to be directed, to appear at a place and time therein named, in no event to be less than 30 days from the date of receipt of the order to show cause why the proposed modification should not be made and the order of modification issued.

(c) If the licensee against whom the order to show cause is directed does not appear at the time and place provided in said order, a final order of modification shall issue forthwith.

CALL SIGNS

§ 12.81. *Assignment of call sign.* (a) The call signs of amateur stations will be assigned systematically by the Commission with the following exceptions: (1) A specific unassigned call sign may be reassigned to the most recent holder thereof; (2) A specific unassigned call sign may be assigned to a previous holder if not under license during the past 5 years; (3) A specific unassigned call sign may be assigned to an amateur organization in memoriam to a deceased member and former holder thereof; (4) A specific call sign may be temporarily assigned to a station connected with an event, or events, of general public interest; (5) An unassigned "two-letter call sign" (a call sign having two letters following the numeral) may be assigned to a previous holder of a two-letter call sign the prefix of which consisted of not more than a single letter.

(b) An amateur call sign will consist of a sequence of one or two letters, a numeral designating the call sign area, and two or three letters. The call sign areas are as follows:

1. Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
2. New York, New Jersey.
3. Pennsylvania, Delaware, Maryland, District of Columbia.
4. Virginia, North and South Carolina, Georgia, Florida, Alabama, Tennessee, Kentucky, Puerto Rico and Virgin Islands.
5. Mississippi, Louisiana, Arkansas, Oklahoma, Texas, New Mexico.
6. California, Hawaii and Pacific possessions except those included in area 7.
7. Oregon, Washington, Idaho, Montana, Wyoming, Arizona, Nevada, Utah, Alaska and adjacent islands.
8. Michigan, Ohio, West Virginia.
9. Wisconsin, Illinois, Indiana.

0. Colorado, Nebraska, North and South Dakota, Kansas, Minnesota, Iowa, Missouri.

§ 12.82. *Transmissions of call signs.* (a)

(1) The operator of an amateur station shall transmit

the call sign of the station or stations (or may transmit the generally accepted identification of the network) being called or communicated with, or shall identify appropriately any other purpose of a transmission, followed by the authorized call sign of the station transmitting:

(i) at the beginning and end of each single transmission or;

(ii) at the beginning and end of a series of transmissions between stations having established communications, each transmission of which is of less than three minutes duration (the identification at the end of such a series may be omitted when the duration of the entire series is less than three minutes), and;

(iii) at least once every ten minutes or as soon thereafter as possible during a series of transmissions between stations having established communications, and;

(iv) at least once every ten minutes during any single transmission of more than ten minutes duration.

(2) The required identification shall be transmitted on the frequency or frequencies being employed at the time and, in accordance with the type of emission authorized thereon, shall be by either telegraphy using the International Morse Code, or telephony. In addition to the foregoing, when a method of communication other than telephony or telegraphy using the International Morse Code, is being used or attempted, the prescribed identification shall also be transmitted by that method.

(b) In addition to complying with the requirements of paragraph (a) of this section, an operator of an amateur station operated as a portable or mobile station using radiotelegraphy shall transmit immediately after the call sign of such station, the fraction-bar character ($\overline{DN}$) followed by the number of the amateur call sign area in which the portable or mobile amateur station is then being operated, as for example:

Example 1. — Portable or mobile amateur station operating in the third amateur call sign area calls a fixed amateur station: W1ABC W1ABC W1ABC DE W2DEF $\overline{DN}$ 3 W2DEF $\overline{DN}$ 3 W2DEF $\overline{DN}$ 3 AR.

Example 2. — Fixed amateur station answers the portable or mobile amateur station: W2DEF W2DEF W2DEF DE W1ABC K.

Example 3. — Portable or mobile amateur station calls a portable or mobile amateur station: W3GHI W3GHI W3GHI DE W4JKL $\overline{DN}$ 4 W4JKL $\overline{DN}$ 4 W4JKL $\overline{DN}$ 4 AR.

When telephony is used, the call sign of the station shall be preceded by the words "this is" or the word "from" instead of the letters "de," followed by an announcement of the geographical location in which the portable or mobile station is being operated.

Example 4. — Portable or mobile amateur radio-telephone station operating in the third call area calls a fixed amateur station: W1ABC W1ABC W1ABC "this is" or the word "from" W2DEF W2DEF W2DEF operating portable (or mobile) 3 miles north of Bethesda, Md., over.

(c) When telephony is used, the transmission of call signs prescribed by paragraphs (a) and (b) of this section may be made by the person transmitting by voice in lieu of a duly licensed operator provided the licensed operator maintains the control required by §12.28.

(d) When using telephony, phonetic aids to identify the call sign of the station may be employed.

(e) In addition to complying with the requirements of paragraph (a) of this section, an operator of an amateur station operated as a mobile station aboard a vessel on the high seas, or aboard an aircraft en route on an international flight, shall, when the vessel or aircraft is outside the 10 call sign areas prescribed by the Commission in §12.81 (b), comply with the following calling procedure:

(1) Mobile operations aboard a vessel.

(i.) When using telegraphy the amateur operator shall transmit immediately after the call sign of the station the fraction bar $\overline{DN}$ followed by the designator MM to indicate that the station is being operated as a mobile station aboard a vessel. In addition, the name of the vessel and its approximate geographical location shall be transmitted at the end of each transmission immediately prior to signing off. If the vessel does not have a name, the number of the vessel shall be transmitted in lieu of the name of the vessel.

(ii.) When using telephony the call sign of the station shall be preceded by the words "this is," or the word "from" followed by the words "maritime mobile," to indicate that the station is being operated as a mobile station aboard a vessel. In addition the name of the vessel and its approximate geographical location shall be transmitted at the end of each transmission immediately prior to signing off. If the vessel does not have a name, the number of the vessel shall be transmitted in lieu of the name of the vessel.

(2) Mobile operations aboard aircraft.

(i.) When using telegraphy the amateur operator shall transmit immediately after the call sign of the station the fraction bar $\overline{DN}$ followed by the designator AM to indicate that the station is being operated as a mobile station aboard an aircraft. In addition, the number of the aircraft and its approximate geographical location shall be transmitted at the end of each transmission immediately prior to signing off.

(ii.) When using telephony the call sign of the station shall be preceded by the words "this is," or the word "from" followed by the words "aeronautical mobile," to indicate that the station is being operated as a mobile station aboard an aircraft. In addition, the number of the aircraft and its approximate geographical location shall be transmitted at the end of each transmission immediately prior to signing off.

PORTABLE AND MOBILE STATIONS

§ 12.91. *Requirements for portable and mobile operation:* (a) Within the continental limits of the United States, its territories, or possessions, an amateur station may be operated as either a portable or a mobile station on any frequency authorized and available for the amateur radio service. Whenever portable operation is, or is likely to be, for an overall period in excess of 48 hours away from the fixed transmitter location designated in the station license, the licensee shall give prior written notice to the Engineer in Charge of the radio inspection district in which such portable operation is intended. This notice is required even though the station is, or is likely to be, operated during any part of this overall period at the fixed transmitter location. Whenever mobile operation is, or is likely to be, for a period in excess of 48 hours without return to the fixed transmitter location designated in the station license, the licensee shall give prior written notice to the Engineer in Charge of the radio inspection district in which such mobile operation is intended. The notice required for either portable or mobile operation shall state the station call sign, the name of the licensee, the date or dates of proposed operation and the contemplated portable station locations, or mobile station itinerary, as specifically as possible. Additional advance written notice shall also be given in accordance with the foregoing whenever such operation away from the fixed station location designated in the station license exceeds one month, and for each additional month of such operation.

(b) Outside the continental limits of the United States, its territories or possessions, an amateur station may be operated as portable or mobile only in the amateur band 28.0 to 29.7 Mc. except that within areas under the jurisdiction of a foreign government, operation is controlled by the laws of that government and the terms of any applicable treaty. (See appendix 4 for such treaties or agreements as are in force and the pertinent terms thereof.) Whenever such portable or mobile operation is, or is likely to be, for a period in excess of 48 hours away from the continental limits of the United States, its territories, or possessions, the licensee shall give prior written notice to the Engineer in Charge of the radio inspection district in which the fixed transmitter site designated in the station license is located. Only one such notice shall be required during any continued absence from the continental limits of the United States, its territories, or possessions.

§ 12.93. *Special provisions for non-portable stations.* The specific provisions of these rules relative to portable stations are not applicable to a non-portable station except that —

(a) An amateur station that has been moved from one permanent location to another permanent location may be operated at the latter location, in accordance with the provisions governing portable stations (including notice to the Engineer in Charge of the district in which the station is located) for a period not exceeding 4 consecutive months, but in no event beyond the expiration date of the license, provided a formal application for modification of license to change the permanent location has been filed with the Commission.

(b) The licensee of an amateur station who changes residence temporarily but retains a permanent residence associated with the fixed station location designated in the station license and moves his amateur station to a temporary location associated with his temporary residence, or the licensee-trustee for an amateur radio society which changes the normal location of its amateur station to a different and temporary location may use the station at such temporary location under the following conditions:

(1) Advance notice in writing shall be given by the amateur station licensee or licensee-trustee to the Commission in Washington, D. C., and, for each month of such operation, to the Engineer in Charge of the radio inspection district in which the station is to be temporarily operated.

(2) Similar notice shall be given for each change in such temporary location, for the return of the station to the former permanent location, or for the establishment of a new permanent location; provided that additional monthly notices to the Engineer in Charge shall not be required when such operation takes place at the fixed station location designated in the station license held by the licensee.

(3) The notice of operation at a temporary location, as required under the preceding provisions of this paragraph, shall clearly identify the station call sign and licensee or licensee-trustee, shall indicate both the permanent and the temporary station locations, shall indicate the address at which the licensee or licensee-trustee can be readily reached during such temporary operation, and shall show the reason why operation at that location is considered temporary rather than a change of permanent location.

(c) When the station is operated under the provisions of this section the calling procedure specified in §12.82 shall be used, including transmissions of the fractional bar character when telegraphy is used followed by the number of the amateur call sign area in which the station is being operated. When telephony is used, an announcement shall be made of the geographical location in which the station is being operated.

§ 12.94. *Special provisions for mobile stations aboard ships or aircraft.* In addition to complying with all other applicable rules, an amateur mobile station operated on board a ship or aircraft must comply with all of the following special conditions: (a) The installation and operation of the amateur mobile station shall be approved by the master of the ship or captain of the aircraft; (b) The amateur mobile station shall be separate from and independent of all other radio equipment, if any, installed on board the same ship or aircraft; (c) The electrical installation of the amateur mobile station shall be in accord with the rules applicable to ships or aircraft as promulgated by the appropriate government agency; (d) The operation of the amateur mobile station shall not interfere with the efficient operation of any other radio equipment installed on board the same ship or aircraft; and (e) The amateur mobile station and its associated equipment, either in itself or in its method of operation, shall not constitute a hazard to the safety of life or property.

USE OF AMATEUR STATIONS

§ 12.101. *Points of communications.* An amateur station may be used to communicate only with other amateur stations, except that in emergencies or for test purposes it may also be used temporarily for communication with other classes of stations licensed by the Commission, and with United States Government stations. Amateur stations may also be used to communicate with any radio station other than amateur which is authorized by the Commission to communicate with amateur stations. Amateur stations may be used also for transmitting signals, or communications, or energy, to receiving apparatus for the measurement of emissions, temporary observation of transmission phenomena, radio control of remote objects, and for similar experimental purposes and for the purposes set forth in section 12.106.

§ 12.102. *No remuneration for use of station.* An amateur station shall not be used to transmit or receive messages for hire, nor for communication for material compensation, direct or indirect, paid or promised.

§ 12.103. *Broadcasting prohibited.* Subject to the provisions of §12.106, an amateur station shall not be used to engage in any form of broadcasting, that is, the dissemination of radio communications intended to be received by the public directly or by the intermediary of relay stations, nor for the retransmission by automatic means of programs of signals emanating from any class of station other than amateur. The foregoing provision shall not be construed to prohibit amateur operators from giving their consent to the rebroadcast by broadcast stations of the transmissions of their amateur stations, provided, that the transmissions of the amateur stations shall not contain any direct or indirect reference to the rebroadcast.

§ 12.104. *Radiotelephone tests.* The transmission of music by an amateur station is forbidden. However, single audio-frequency tones may be transmitted for test purposes of short duration for the development and perfection of amateur radiotelephone equipment.

§ 12.105. *Codes and ciphers prohibited.* The transmission by radio of messages in codes or ciphers in domestic and international communications to or between amateur stations is prohibited. All communications regardless of type or emission employed shall be in plain language except that generally recognized abbreviations established by regulation or custom and usage are permissible as are any other abbreviations or signals when the intent is not to obscure the meaning but only to facilitate communications.

§ 12.106.* *One-way communications.* In addition to the experimental one-way transmissions permitted by §12.101, the following kinds of one-way communications, addressed to amateur stations, are authorized and will not be construed as broadcasting:

(a) Emergency communications, including bona-fide emergency drill practice transmissions;
(b) Information bulletins consisting solely of subject matter having direct interest to the amateur radio service as such;
(c) Round-table discussions or net-type operations where more than two amateur stations are in communication, each station taking a turn at transmitting to other station(s) of the group;
and
(d) Code practice transmissions intended for persons learning or improving proficiency in the International Morse Code.

§ 12.107 *Special provisions regarding radio teleprinter transmissions.* The following special conditions shall be observed during the transmission of radio teleprinter signals on authorized frequencies by amateur stations:

(a) A single channel five-unit (start-stop) teleprinter code shall be used which shall correspond to the International Telegraphic Alphabet No. 2 with respect to all letters and numerals (including the slant sign or fraction bar) but special signals may be employed for the remote control of receiving printers, or for other purposes, in "figures" positions not utilized for numerals. In general, this code shall conform as nearly as possible to the teleprinter code or codes in common commercial usage in the United States.

(b) The nominal transmitting speed of the radio teleprinter signal keying equipment shall be adjusted as nearly as possible to the standard speed of 60 words per minute and, in any event, within the range 55 to 65 words per minute.

(c) When frequency-shift keying (type F-1 emission) is utilized, the deviation in frequency from the mark signal to the space signal, or from the space signal to the mark signal, shall be adjusted as nearly as possible to 850 cycles and, in any event, within the range 800 to 900 cycles per second.

(d) When audio-frequency-shift keying (type A-2 or type F-2 emission) is utilized, the highest fundamental modulation audio frequency shall not exceed 3000 cycles per second, and the difference between the modulating audio frequency for the mark signal and that for the space signal shall be adjusted as nearly as possible to 850 cycles and, in any event, within the range 800 to 900 cycles per second.

ALLOCATION OF FREQUENCIES

§ 12.111. *Frequencies and types of emission for use of amateur stations.* Subject to the limitations and restrictions set forth in this section and in § 12.114, the following frequency bands and types of emissions are allocated and available for amateur station operation:

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*Editor's Note: Adequately-qualified amateurs interested in undertaking, purely as an amateur activity, special technical investigations, such as observation and measurement of propagation phenomena, may apply for special temporary authority to employ types of emission other than those provided for in § 12.111. Requests for such authority should include full details and should be addressed to the Secretary, Federal Communications Commission, Washington 25, D. C.

(a) 1800 to 2000 kc. The use of this band is on a shared basis with the Loran system of radionavigation. The amateur service may use, in any area, whichever bands, 1800–1825, 1875–1900, 1900–1925 or 1975–2000 kc, are not required for Loran in that area, in accordance with the following conditions:

(1) The use of these frequencies by the amateur service shall not be a bar to the expansion of the radionavigation (Loran) service.

(2) The use of these frequencies by stations in the amateur service shall not cause harmful interference to the Loran system of radionavigation. If an amateur station causes such interference, the station licensee shall, as directed by the Commission, immediately cease operation on the frequencies involved.

(3) Only type A1 or A3 emission shall be employed.

(4) Amateur operation shall be limited to the following areas, to the indicated frequency bands within each such area, and to the indicated maximum plate power input to the tube or tubes supplying energy to the antenna during day and night hours, respectively, on such frequencies:

Area	*Authorized Bands, kc.*	*DC Plate Input Power in Watts*	
		Day	*Night*
Minnesota, Iowa, Missouri, Arkansas, Louisiana and states to the east of these states, including District of Columbia	1800–1825 1875–1900	500	200
North Dakota, South Dakota, Nebraska, Colorado, New Mexico and states to the west of these states except the State of Washington	1900–1925 1975–2000	500	200
State of Washington	1900–1925 1975–2000	200	50
Texas, Oklahoma and Kansas	1800–1825 1875–1900	200	75
Hawaiian Islands	1900–1925 1975–2000	500	200
Puerto Rico and Virgin Islands	1800–1825 1875–1900	500	200
Alaska, Guam and other territories and possessions of the United States not listed above.	None	No operation	No operation

(5) The provisions of this subparagraph shall be considered as temporary in the sense that they shall remain subject to cancellation or to revision, in whole or in part, by order of the Commission without hearing whenever the Commission shall deem such cancellation or revision to be necessary or desirable in the light of the priority within this band of the Loran system of radionavigation.

(b) 3500 to 4000 kc. using type A1 emission and, on frequencies 3500 to 3800 kc., using type F-1 emission and, on frequencies 3800 to 4000 kc. using type A3 emission and narrow band frequency or phase modulation for radiotelephony; to those stations located within the continental limits of the United States, the Territories of Alaska and Hawaii, Puerto Rico, the Virgin Islands and all United States possessions lying west of the Territory of Hawaii to 170° west longitude.

(c) 7000 to 7300 kc, using type A-1 emission and, on frequencies 7000 to 7200 kc, using type F-1 emission and, on frequencies 7200 to 7300 kc, using type A-3 emission or narrow band frequency or phase modulation for radiotelephony.

(d) 14,000 to 14,350 kc., using type A-1 emission, 14,000 to 14,200 kc. and 14,300 to 14,350 kc. using type F-1 emission and on frequencies 14,200 to 14,300 kc., type A-3 emission or narrow band frequency or phase modulation for radiotelephony.

(e) 21.00 to 21.45 Mc., using type A-1 emission; 21.00 to 21.25 Mc., using type F-1 emission; 21.25 to 21.45 Mc., using type A-3 emission and narrow band frequency or phase modulation for telephony.

(f) 26.960 to 27.230 Mc. using A0, A1, A2, A3, and A4 emission and also special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques), subject to such interference as may result from the emissions of industrial, scientific and medical devices within 160 kc. of the frequency 27.120 Mc.

(g) 28.0 to 29.7 Mc. using type A1 emission and, on frequencies 28.5 to 29.7 Mc. using type A3 emission and narrow band frequency or phase modulation for radiotelephony and, on frequencies 29.0 to 29.7, using special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques).

(h) 50.0 to 54.0 Mc. using types A1, A2, A3, and A4 emission and narrow band frequency or phase modulation for radiotelephony and, on frequencies 52.5 to 54.0 Mc. special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques)

(i) 144 to 148 Mc., using types A0, A1, A2, A3, and A4 emission and special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques).

(j) 220 to 225 Mc.,[2] using types A0, A1, A2, A3, and A4 emission and special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques).

(k) 420 to 450 Mc., using types A0, A1, A2, A3, A4, and A5 emissions and special emissions for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques). Peak antenna power shall not exceed 50 watts in order to minimize interference to aircraft altimeters temporarily allocated to this band.

(l) 1215 to 1300 Mc. using types A0, A1, A2, A3, A4, and A5 emission and special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques).

(m) 2300 to 2450 Mc., 3300 to 3500 Mc., 5650 to 5925 Mc., 10,000 to 10,500 Mc., 21,000 to 22,000 Mc., and any frequency or frequencies above 30,000 Mc., using on these frequencies types A0, A1, A2, A3, A4, A5 emission and special emission for frequency modulation (radiotelephone transmissions and radiotelegraph transmissions employing carrier shift or other frequency modulation techniques), and pulse emission. Operations in the frequency bands 2300 to 2450 Mc. and 5650 to 5925 Mc. are subject to such interference between 2400 and 2450 Mc. and between 5775 and 5925 Mc., respectively, as may result from emissions of industrial, scientific and medical devices on the frequencies 2450 and 5850 Mc., respectively.

§ 12.113. *Individual frequency not specified.* Transmissions by an amateur station may be on any frequency within

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EDITOR'S NOTE: The types of emission referred to in the amateur rules are as follows:

Type A0 — Steady, unmodulated, pure carrier.
Type A1 — Telegraphy on pure continuous waves.
Type A2 — Amplitude tone-modulated telegraphy.
Type A3 — Amplitude-modulated telephony.
Type A4 — Facsimile.
Type A5 — Television.
Type F1 — Carrier-shift telegraphy.
Type F2 — Audio frequency-shift telegraphy.

[2] In those portions of the States of Texas and New Mexico in the area bounded on the south by parallel 31° 53′ N., on the east by longitude 105° 40′ W., on the north by parallel 33° 24′ N., and on the west by longitude 106° 40′ W., the frequency band 220–225 Mc. is not available for use by amateur stations engaged in normal amateur operation between the hours of 0500 and 1800 local time Monday through Friday inclusive of each week. However, the entire frequency band 220–225 Mc. shall be aplicable in all areas to those amateur stations authorized to operate in an organized civil defense network during all periods when civil defense emergencies exist and, in addition, special arrangements for civil defense drills between the hours and within the area set forth above may be made upon mutual agreement between the Federal Communications Commission Engineer in Charge at Dallas, Texas, and the Area Frequency Coordinator at White Sands, New Mexico, if it appears necessary to conduct such drills. Such arrangements shall specify dates and times, and will depend upon the degree of use of the frequency band at White Sands at any particular time.

any authorized amateur band. Sideband frequencies resulting from keying or modulating a carrier wave shall be confined within the authorized amateur band.

§ 12.114. *Types of emission.* (a) Type A0 emission, where not specifically designated in the bands listed in § 12.111, may be used for short periods of time when required for authorized remote control purposes or for experimental purposes. However, these limitations do not apply where type A0 emission is specifically designated.

(b) [Deleted]

(c) The use of narrow band frequency or phase modulation is subject to the conditions that the bandwidth of the modulated carrier shall not exceed the bandwidth occupied by an amplitude-modulated carrier of the same audio characteristics, and that the purity and stability of such emissions shall be maintained in accordance with the requirements of § 12.133.

EQUIPMENT AND OPERATION

§ 12.131. *Maximum authorized power.* Except on frequencies within the band 420–450 Mc. (where peak antenna power shall not exceed 50 watts), each amateur transmitter may be operated with a power input not exceeding 1 kilowatt to the plate circuit of the final amplifier stage of an amplifier-oscillator transmitter or to the plate circuit of an oscillator transmitter. An amateur transmitter operating with a power input exceeding 900 watts to the plate circuit shall provide means for accurately measuring the plate power input to the vacuum tube or tubes supplying power to the antenna.

§ 12.132. *Power supply to transmitter.* The licensee of an amateur station using frequencies below 144 Mc. shall use adequately filtered direct-current plate power supply for the transmitting equipment to minimize modulation from this source.

§ 12.133. *Purity and stability of emissions.* Spurious radiation from an amateur station being operated with a carrier frequency below 144 Mc. shall be reduced or eliminated in accordance with good engineering practice. This spurious radiation shall not be of sufficient intensity to cause interference in receiving equipment of good engineering design including adequate selectivity characteristics, which is tuned to a frequency or frequencies outside the frequency band of emission normally required for the type of emission being employed by the amateur station. In the case of A3 emission, the amateur transmitter shall not be modulated to the extent that interfering spurious radiation occurs, and in no case shall the emitted carrier wave be amplitude-modulated in excess of 100 per cent. Means shall be employed to insure that the transmitter is not modulated in excess of its modulation capability for proper technical operation. For the purposes of this section a spurious radiation is any radiation from a transmitter which is outside the frequency band of emission normal for the type of transmission employed, including any component whose frequency is an integral multiple or submultiple of the carrier frequency (harmonics and subharmonics), spurious modulation products, key clicks and other transient effects, and parasitic oscillations. When using amplitude modulation on frequencies below 144 Mc., simultaneous frequency modulation is not permitted and when using frequency modulation on frequencies below 144 Mc. simultaneous amplitude modulation is not permitted. The frequency of the emitted carrier wave shall be as constant as the state of the art permits.

§ 12.134. *Modulation of carrier wave.* Except for brief tests or adjustments and except for operation in the band 26.960 to 27.230 megacycles, an amateur radiotelephone station shall not emit a carrier wave on frequencies below 144 megacycles unless modulated for the purpose of communication.

§ 12.135. *Frequency measurement and regular check.* The licensee of an amateur station shall provide for measurement of the emitted carrier frequency or frequencies and shall establish procedure for making such measurement regularly. The measurement of the emitted carrier frequency or frequencies shall be made by means independent of the means used to control the radio frequency or frequencies generated by the transmitting apparatus and shall be of sufficient accuracy to assure operation within the amateur frequency band used.

§ 12.136. *Logs.* Each licensee of an amateur station shall keep an accurate log of station operation, which shall include the following:

(a) The date and time of each transmission. (The date need only be entered once for each day's operation. The expression "time of each transmission" means the time of making a call and need not be repeated during the sequence of communication which immediately follows; however, an entry shall be made in the log when signing off so as to show the period during which communication was carried on.)

(b) The signature of each licensed operator who manipulates the key of a radiotelegraph transmitter or the signature of each licensed operator who operates a transmitter of any other type and the name of any person not holding an amateur operator license who transmits by voice over a radiotelephone transmitter. The signature of the operator need only be entered once in the log, in those cases when all transmissions are made by or under the supervision of the signatory operator, provided a statement to that effect also is entered. The signature of any other operator who operated the station shall be entered in the proper space for that operator's transmission.

(c) Call sign of the station called. (This entry need not be repeated for calls made to the same station during any sequence of communication, provided the time of signing off is given.)

(d) The input power to the oscillator, or to the final amplifier stage where an oscillator-amplifier transmitter is employed. (This need be entered only once, provided the input power is not changed.)

(e) The frequency band used. (This information need be entered only once in the log for all transmissions until there is a change in frequency to another amateur band.)

(f) The type of emission used. (This need be entered only once until there is a change in the type of emission.)

(g) The location of the station (or the approximate geographical location of a mobile station) at the time of each transmission. (This need be entered only once provided the location of the station is not changed. However, suitable entry shall be made in the log upon changing the location. Where operating at other than a fixed location, the type and identity of the vehicle or other mobile unit in which the station is operated shall be shown.)

(h) The message traffic handled. (If record communications are handled in regular message form, a copy of each message sent and received shall be entered in the log or retained on file at the station for at least 1 year.)

§ 12.137. *Retention of logs.* The log shall be preserved for a period of at least 1 year following the last date of entry. The copies of record communications and station log required by section 12.136 shall be available for inspection by authorized representatives of the Commission.

SPECIAL CONDITIONS

§ 12.151. *Additional conditions to be observed by licensee.* In all respects not specifically covered by these regulations each amateur station shall be operated in accordance with good engineering and good amateur practice.

§ 12.152. *Restricted operation.* (a) If the operation of an amateur station causes general interference to the reception of transmissions from stations operating in the domestic broadcast service when receivers of good engineering design including adequate selectivity characteristics are used to receive such transmissions and this fact is made known to the amateur station licensee, the amateur station shall not be operated during the hours from 8 P.M. to 10:30 P.M., local time, and on Sunday for the additional period from 10:30 A.M. until 1 P.M., local time, upon the frequency or frequencies used when the interference is created. (b) In general, such steps as may be necessary to minimize interference to stations operating in other services may be required after investigation by the Commission.

§ 12.153. *Second notice of same violation.* In every case where an amateur station licensee is cited within a period of twelve consecutive months for the second violation of the provisions of sections 12.111, 12.113, 12.114, 12.132, or 12.133, the station licensee, if directed to do so by the Commission, shall not operate the station and shall not permit it to be operated from 6 P.M. to 10:30 P.M., local time, until written notice has been received authorizing the resumption of full-time operation. This notice will not be issued until the licensee has reported on the results of tests which he has conducted with at least two other amateur stations at hours other than 6 P.M. to 10:30 P.M. local time. Such tests are to be made for the specific purposes of aiding the licensee in determining whether the emissions of the station are in accordance with the Commission's rules. The licensee shall report to the Commission the observations made by the coöperating amateur licensees in relation to the reported violations. This report shall include a statement as to the corrective measures taken to insure compliance with the rules.

§ 12.154. *Third notice of same violation.* In every case where an amateur station licensee is cited within a period of twelve consecutive months for the third violation of sections 12.111, 12.113, 12.114, 12.132 or 12.133, the station licensee, if directed by the Commission, shall not operate the station and shall not permit it to be operated from 8 A.M. to 12 midnight, local time, except for the purposes of transmitting a pre-arranged test to be observed by a monitoring station of the Commission to be designated in each particular case. The station shall not be permitted to resume operation during these hours until the licensee is authorized by the Commission, following the test, to resume full-time operation. The results of the test and the licensee's record shall be considered in determining the advisability of suspending the operator license or revoking the station license, or both.

§ 12.155. *Answers to notices of violations.* Any licensee receiving official notice of a violation of the terms of the Communications Act of 1934, as amended, any legislative act, Executive order, treaty to which the United States is a party, or the Rules and Regulations of the Federal Communications Commission, shall, within 3 days from such receipt, send a written answer, direct to the office of the Commission originating the official notice: Provided, however, that if an answer cannot be sent nor an acknowledgment made within such 3-day period by reason of illness or other unavoidable circumstances, acknowledgment and answer shall be made at the earliest practicable date with a satisfactory explanation of the delay. The answer to each notice shall be complete in itself and shall not be abbreviated by reference to other communications or answers to other notices. If the notice relates to some violation that may be due to the physical or electrical characteristics of transmitting apparatus, the answer shall state fully what steps, if any, are taken to prevent future violations, and if any new apparatus is to be installed, the date such apparatus was ordered, the name of the manufacturer, and promised date of delivery. If the notice of violation relates to some lack of attention or improper operation of the transmitter, the name of the operator in charge shall be given.

§ 12.156 *Operation in emergencies.* In the event of an emergency disrupting normally available communication facilities in any wide-spread area or areas, the Commission, in its discretion, may declare that a general state of communications emergency exists, designate the area or areas concerned, and specify the amateur frequency bands, or segments of such bands for use only by amateurs participating in emergency communication within or with such affected area or areas. Amateurs desiring to request the declaration of such a state of emergency should communicate with the Commission's Regional Manager of the area concerned. Whenever such declaration has been made, operation of and with amateur stations in the area concerned shall be only in accordance with the requirements hereinafter set forth, but such requirements shall in nowise affect other normal amateur communication in the affected area when conducted on frequencies not designated for emergency operation.

(a) All transmissions within all designated amateur emergency communication bands other than communications relating directly to relief work, emergency service, or the establishment and maintenance of efficient amateur radio networks for the handling of such communications, shall be suspended. Incidental calling, answering, testing or working (including casual conversation, remarks or messages) not pertinent to constructive handling of the emergency situation shall be prohibited within those bands.

(b) The Commission may designate certain amateur stations to assist in the promulgation of information relating to the declaration of a general state of communications emergency, to monitor the designated amateur emergency communications bands, and to warn non-complying stations observed to be operating in those bands. Such station, when so designated, may transmit for that purpose on any frequency or frequencies authorized to be used by that station, provided such transmissions do not interfere with essential emergency communications in progress; however, such transmissions shall preferably be made on authorized frequencies immediately adjacent to those segments of the amateur bands being cleared for the emergency. Individual transmissions for the purpose of advising other stations of the existence of the communications emergency shall refer to this section by number (§ 12.156) and shall specify, briefly and concisely, the date of the Commission's declaration, the area and nature of the emergency, and the amateur frequency bands or segments of such bands which constitute the amateur emergency communications bands at the time. The designated stations shall not enter into discussions with other stations beyond furnishing essential facts relative to the emergency, or acting as advisors to stations desiring to assist in the emergency, and the operators of such designated stations shall report fully to the Commission the identity of any stations failing to comply, after notice, with any of the pertinent provisions of this section.

(c) The special conditions imposed under the provisions of this section shall cease to apply only after the Commission, or its authorized representative, shall have declared such general state of communications emergency to be terminated; however, nothing in this paragraph shall be deemed to prevent the Commission from modifying the terms of its declaration from time to time as may be necessary during the period of a communications emergency, or from removing those conditions with respect to any amateur frequency band or segment of such band which no longer appears essential to the conduct of the emergency communications.

§ 12.157. *Obscenity, indecency, profanity.* No licensed radio operator or other person shall transmit communications containing obscene, indecent, or profane words, language, or meaning.

§ 12.158. *False signals.* No licensed radio operator shall transmit false or deceptive signals or communications by radio, or any call letter or signal which has not been assigned by proper authority to the radio station he is operating.

§ 12.159. *Unidentified communications.* No licensed radio operator shall transmit unidentified radio communications or signals.

§ 12.160. *Interference.* No licensed radio operator shall willfully or maliciously interfere with or cause interference to any radio communication or signal.

§ 12.161. *Damage to apparatus.* No licensed radio operator shall willfully damage, or cause or permit to be damaged, any radio apparatus or installation in any licensed radio station.

§ 12.162. *Fraudulent licenses.* No licensed radio operator or other person shall obtain or attempt to obtain, or assist another to obtain or attempt to obtain, an operator license by fraudulent means.

RULES GOVERNING
RADIO AMATEUR CIVIL EMERGENCY SERVICE

GENERAL

§ 12.200. *Temporary nature of this service.* (a) The Radio Amateur Civil Emergency Service provides a temporary phase of amateur operation for Civil Defense communications purposes only, and the rules are limited in their force and effect to the period of the present national emergency, including any emergency which may necessitate invoking of the President's War Emergency Powers under the provisions of Section 606 of the Communications Act of 1934, as amended.

(b) Pursuant to the provisions of Section 4 (j) of the Communications Act of 1934, as amended, records relating to the Radio Amateur Civil Emergency Service shall not be open to general public inspection.

§ 12.201. *Definitions.* For the purposes of this Sub-Part, the following definitions are applicable:

(a) *Radio Amateur Civil Emergency Service.* A temporary radio-communication service carried on by licensed amateur radio stations while operating on specifically designated segments of the regularly allocated amateur frequency bands under the direction of authorized local, regional, or federal civil defense officials pursuant to an approved civil defense communications plan.

(b) *Radio Amateur Civil Emergency Station.* An amateur radio station which is authorized to operate in the Radio Amateur Civil Emergency Service for the purpose of transmitting and receiving civil defense communications.

(c) *Civil defense communications.* Communications or signals essential to the conduct of civil defense activities of duly authorized civil defense organizations, including communications directly concerning safety of life, preservation of property, maintenance of law and order, alleviation of human suffering and need and dissemination of warnings of enemy attack to the civilian population in case of actual or impending armed attack or in any disaster or other incident endangering the public welfare. Such communications may also include transmissions necessary to establishment and maintenance of the radio system and communications essential to the training of civil defense personnel.

(d) *Civil defense authority.* The legally appointed Director of Civil Defense, or his authorized alternate or representative, for the particular geographical area (city, county, etc.) which a proposed radio station is intended to serve, and who is responsible to local governmental authority for protection and aid to the civilian population in the event of armed attack or of any disaster or other incident endangering public safety.

(e) *Civil Defense Communications Officer.* The official of any duly constituted civil defense organization having direct responsibility under the Director of that organization for the provision, organization, maintenance, readiness, and utilization of all means of communication to be used by such civil defense organization in the performance of its lawful functions.

(f) *Civil Defense Radio Officer.* The duly designated official of a legally constituted civil defense organization who is directly responsible either to the Communications Officer or to the Director of such civil defense organization for the provision, organization, maintenance, readiness, and utilization of radio communications for civil defense use.

(g) *Radio Amateur Civil Emergency Network.* All radio amateur civil emergency stations which are intended to be included in the civil defense communications plan of the area concerned, and which operate or are to operate in conjunction with a single control station. Such network may be made up of several separately authorized radio amateur civil emergency stations or units of such stations, or may be made up of several units of the same station operated at different locations. In addition, the same radio amateur civil emergency station or any unit of such station may be a part of more than one network; e.g., the control station of one network may also be the control station or a member station of another network operated in conjunction therewith.

(h) *Control station.* The term "control station" or "net control station" means any authorized Radio Amateur Civil Emergency Service station unit designated by the civil defense radio officer, with the approval of the Director of civil defense or the Civil Defense Communication officer, to direct the use and operation of other station units of the same radio amateur civil emergency network.

(i) *Civil defense communications plan.* A civil defense communications plan is the plan under which communications facilities are provided to all branches and phases of the civil defense organization in the area concerned and for all of its activities. Such plan may be drawn up in accordance with the needs of the particular area affected and the facilities, including licensed radio operators and stations available in that particular area. Plans need not be uniform but to be acceptable to the Commission they must comply with the following:

(1) The plan must be clearly described in writing, and it may include diagrams and sketches. It must include a general description of the facilities and personnel available to provide communications for civil defense purposes and the expected usage to be made thereof.

(2) The plan must have been approved by the state or territorial and the federal civil defense authorities having jurisdiction of the area affected.

(3) The plan must include the name, address, official title, and a statement of the qualifications of the Civil Defense Radio Officer (and of any and all alternate Radio Officers) responsible for the organization, training, and utilization of the radio amateur civil emergency station networks under that plan, and the name, address, and official title of the civil defense official responsible for the coordination of all civil defense activities of the area concerned.

(4) The plan must include a general description of each radio amateur civil emergency station network under the jurisdiction of each respective Civil Defense Radio Officer, showing location of fixed installations, purpose, area of activity to be served, an estimate of the number of radio amateur stations and independent operating units of such stations intended to be used in the network, and a description, including the location and call sign, of its control station and any alternate control station or stations.

(5) The plan must include a general statement as to the frequency bands to be used by the radio amateur civil emergency station networks and the approximate number of stations, or units of such stations, to be operated in each such band, together with a description of the method which has been adopted for liaison and coordination of frequency usage with other similar networks in the same and adjacent areas.

(6) The plan must include a statement setting forth the facilities available to the area and the procedures to be followed in determining the loyalty and general reliability of all civil defense Radio Officers, amateur radio station licensees and radio operators intended to be utilized in the implementation of that plan. (See § §12.214 (b), 12.215 (c) and 12.241 (a) of this Sub-Part.)

§ 12.202. *Applicability of Rules Governing Amateur Radio Stations and Operators.* In all cases not specifically covered by the regulations contained in this sub-part, licensed amateur stations authorized to be operated in the Radio Amateur Civil Emergency Service shall be governed by the provisions of the Rules Governing Amateur Radio Stations and Operators (Sub-Part A of this part) which are not in conflict herewith. In any case of conflict, the rules governing the Radio Amateur Civil Emergency Service shall govern in respect to any station operated in that service.

ORGANIZATION

§ 12.211. *Organization of networks.* To supplement or extend other means of communication available to the civil defense organization or to provide necessary communications for which no other means exists, local radio amateur civil emergency station networks shall be organized by the civil defense authority of the area concerned and under the immediate direction of the Civil Defense Radio Officer. Such networks shall include all licensed amateur radio stations which are intended to be included in the civil defense communications plan of the area concerned. In any particular area there may be several such networks and each network may be independent of the others. Whenever there is more than one network in the same area, all such networks must share, under a single civil defense communications plan, the available frequencies in an efficient and orderly manner. The various networks in adjacent areas shall establish proper liaison and a description of the arrangements made shall become a part of their respective civil defense communications plans. Such arrangements shall provide for the efficient sharing of frequencies, plans for operating procedure designed to avoid mutual interference, and the exchange of communications facilities upon an inter-area basis where need for such exchange may arise.

§ 12.212. *Approval of civil defense communications plans.* (a) All civil defense communications plans which provide for the utilization of radio amateur civil emergency stations for civil defense purposes must be submitted to and approved by the responsible state (or territorial) and federal civil defense authorities before the licensed amateur stations intended to be used will be authorized to operate in the radio amateur civil emergency service.

(b) Material changes or modifications in such civil defense communications plans which alter the basic information required to be submitted shall be submitted for approval in the same manner as the original plans.

(c) Written certification of approval by the competent state (or territorial) and federal civil defense authorities of each civil defense communications plan, or of any changes or modifications thereof, shall accompany the copies of such plans, changes, or modifications, which are submitted to the Commission in accordance with the provisions of this part.

§ 12.213. *Certification of Civil Defense Radio Officer.* (a) Certification of the Civil Defense Radio Officer shall be made on FCC Form No. 482. Such form shall be executed by the civil defense authority responsible for the coordination of all civil defense activities of the area concerned and show: (1) the name, address, and area of responsibility of such civil defense radio officer, (2) statement by him that he has accepted such appointment and agrees to perform faithfully the duties of that office, including those prescribed by these rules, (3) a certification by the responsible civil defense authority that he has satisfied himself that the named civil defense radio officer is fully qualified in accordance with the provisions of §12.214 of this Sub-Part, and (4) the effective date of the appointment of the civil defense radio officer and the name of any previous civil defense radio officer whose appointment is terminated.

(b) FCC Form No. 482, when completed in accordance with the foregoing, shall be forwarded to the Commission via the responsible state (or territorial) and federal civil defense officials whose approval (or disapproval) shall be clearly indicated on the form.

§ 12.214. *Qualifications of Civil Defense Radio Officer.* No person shall be considered qualified as a Civil Defense Radio Officer until he shall have been found to satisfy the following minimum requirements:

(a) He shall hold either (1) a valid commercial radio operator's license of either first or second class (radiotelephone or radiotelegraph) issued by the Commission or (2) a valid amateur operator's license issued by the Commission (other than Technician or Novice Class).

(b) A determination shall have been made as to his loyalty to the United States and his general reliability, in accordance with the procedures provided in the approved civil defense communications plan of the area concerned.

(c) It shall have been determined that his technical and administrative qualifications are adequate for the proper performance of his duties.

§ 12.215. *Duties of Civil Defense Radio Officer.* The duties of the Civil Defense Radio Officer shall include among such other duties as may be assigned or as may be required in accordance with the provisions of these rules:

(a) The direction and supervision of all radio stations forming the radio amateur civil emergency networks in accordance with the approved civil defense communications plan for the area involved.

(b) Provision for adequate monitoring of all transmissions of the stations under his supervision to assure compliance with the rules and regulations of the Commission, and to guard against improper use of the radio stations and intentional or inadvertent transmissions which might jeopardize the defense or security of the United States.

(c) The recommendation to the Commission for the granting of authorizations to individual amateurs for operation in this service, and certification to the Commission as to the loyalty to the United States and reliability of such individuals and the certification required in accordance with Section 12.223.

(d) The recommendation to the Commission for cancellation of any authorization previously recommended or certified whenever subsequent investigation or circumstances indicate that the original recommendation or certification should not have been made.

STATION AUTHORIZATIONS

§ 12.221. *Station authorization required.* No radio station may be operated in the Radio Amateur Civil Emergency Service except pursuant to an authorization for such operation issued by the Federal Communications Commission.

§ 12.222. *Eligibility for station authorization.* An authorization to operate a station in the Radio Amateur Civil Emergency Service will be issued only to a person who holds an amateur radio operator license, other than Technician or Novice Class, and an appropriate amateur radio station license.

§ 12.223. *Filing of application.* Each application for a station authorization shall be submitted on FCC Form 481-1 signed under oath or affirmation by the applicant and countersigned by the appropriate civil defense radio officer, who shall certify to the following:

(a) That the applicant has satisfied all requirements (both local and federal) for participation in the civil defense organization and is actually enrolled as a member of the local organization which serves the area where the station will operate.

(b) That the amateur station licensed in the name of the applicant has been approved for and, when authorized by the Commission, will actually constitute a unit of a civil defense communications network in accordance with an approved civil defense communications plan or amendment thereof.

§ 12.224. *Additional data required.* Each application for a station authorization in the Radio Amateur Civil Emergency Service shall be accompanied by the following data unless such material has already been submitted to the Commission, in which case the application shall clearly identify the material previously submitted:

(a) A copy of the approved communications plan (as defined in this part) for the civil defense communications network in which the station will operate, together with a copy of each approved amendment, change or modification of that plan.

(b) The official certification of the Civil Defense Radio Officer as provided in this sub-part.

§ 12.225. *Single application for all equipment under one amateur station license.* Only one application need be filed for any one amateur station, including all transmitting equipment under the control of the licensee of that station, even though individual units of such station are capable of being operated and are intended to be operated independently at different locations, either as portable or mobile stations with no fixed locations. No distinction need be made between those units which are personally owned by the amateur station licensee and those units which are otherwise under his technical control for operation in this service.

§ 12.226. *Issuance o̧ station authorization.* An authorization to operate in this service will be issued in the discretion of the Commission upon satisfactory completion of all requirements of these rules and proper certification that the requirements of the civil defense organization for which the station will be used have been or are being complied with. The station authorization (Form 481-2) will be forwarded to the Civil Defense Radio Officer for delivery to the applicant. Such authorization will be accompanied by a stub (Form 481-3) which may be retained by the civil defense radio officer for his records.

§ 12.227. *Term of station authorization.* (a) Authorization to operate an amateur station in the Radio Amateur Civil Emergency Service will be issued for a term running concurrently with the term of the amateur radio station license. Application for renewal of such authorization shall be filed concurrently with application for renewal of the basic amateur radio station license.

(b) Whenever, under rules contained in sub-part A hereof, modification of the basic amateur station license becomes necessary, if such modification affects the information submitted with the original application for a license in this service, application for modification of the Radio Amateur Civil Emergency station license shall be submitted concurrently therewith.

(c) Nothing in this section shall be construed to alter or amend the temporary nature of a station authorization in the Radio Amateur Civil Emergency Service and the Commission's authority to cancel or amend it in accordance with the applicant's agreement as indicated on the initial application for station authorization.

§ 12.228. *Cancellation of station authorization.* (a) Each authorization for operation in the Radio Amateur Civil Emergency Service shall be issued with the express provision that such authorization is subject to revocation or cancellation without hearing whenever, in the opinion of the Commission, the security of the United States or the proper functioning of the Radio Amateur Civil Emergency Service would be served thereby or termination of the national emergency makes it unnecessary to continue the operation of stations in this service.

(b) The station authorization shall be submitted to the Commission (via the Civil Defense Radio Officer) for cancellation under the following circumstances:

(1) The station for which the authorization was issued becomes inactive for a period of three months or it is not planned to use the station in the radio amateur civil emergency network for a period of at least three months.

(2) The basic amateur radio station license of the station has expired and has not been renewed.

(3) In cases where the amateur radio station license and the radio amateur civil emergency station authorization have both been modified, the original authorization of the latter shall be submitted to the Commission immediately upon receipt by the licensee of a new or modified authorization.

TECHNICAL REQUIREMENTS

§ 12.231. *Frequencies available.* (a) The following tabulation indicates the frequency bands, within the regularly allocated amateur frequency bands, which are available for use by stations in the Radio Amateur Civil Emergency Service. These frequency bands may be used, on a non-exclusive basis, by the classes of radio amateur civil emergency stations or units of such stations indicated, and only with the types of emission shown in the right-hand column.

(1) For use only by authorized stations or units of such stations which are operated under the direct supervision of duly designated and responsible officials of the civil defense organization:

Frequency band	*Authorized emission*
1800–1825 kc [1]	0.1 A1, 6 A3
1875–1900 kc [1]	0.1 A1, 6 A3
1900–1925 kc [1]	0.1 A1, 6 A3
1975–2000 kc [1]	0.1 A1, 6 A3
3500–3510 kc	0.1 A1, 1.1 F1
3990–4000 kc	0.1 A1, 1.1 F1, 6 A3, 6 F3

(2) For use by all authorized stations:

Frequency band	*Authorized emission*
28.55– 28.75 Mc	0.1 A1, 6 A3, 6 A4, 6 F3
29.45– 29.65 Mc	0.1 A1, 1.1 F1, 6 A3, 6 A4, 40 F3
50.35– 50.75 Mc	0.1 A1, 6 A2, 6 A3, 6 A4, 6 F3
53.35– 53.75 Mc	0.1 A1, 1.1 F1, 6 A2, 6 F2, 6 A3, 6 A4, 40 F3
145.17–145.71 Mc	0.1 A1, 1.1 F1, 6 A2, 6 F2, 6 A3, 6 A4, 40 F3
146.79–147.33 Mc	0.1 A1, 1.1 F1, 6 A2, 6 F2, 6 A3, 6 A4, 40 F3
220–225 Mc	0.1 A1, 1.1 F1, 6 A2, 6 F2, 6 A3, 6 A4, 40 F3

(b) The selection and use of specific frequencies within the authorized frequency bands by stations in the Radio Amateur Civil Emergency Service shall be in accordance with a coordinated local area and adjacent area civil defense communications plan and applicable rules of this part.

(c) At such time as any or all of these frequency bands are withdrawn from availability to stations operating in the Amateur Radio Service, such bands shall be jointly available to stations in the Radio Amateur Civil Emergency Service and to stations in the military services for training and tactical operations. At that time, in the areas where interference might occur, local mutual arrangements shall be made regarding times of operation such as to preclude or satisfactorily alleviate interference. In time of actual civil defense emergency, stations in the Radio Amateur Civil Emergency Service shall have absolute priority.

§ 12.232. *Classification of emissions.* (a) For the purposes of this Sub-Part, the authorized emissions, as contained in the table of Section 12.231, are defined as follows:

0.1 A1 — Continuous wave telegraphy.
1.1 F1 — Frequency shift telegraphy.
6 A2 — Telegraphy amplitude modulated at audio frequency.
6 F2 — Telegraphy frequency modulated at audio frequency.
6 A3 — Commercial quality amplitude modulated telephony.
6 F3 — Narrow band frequency or phase modulated telephony.
40 F3 — Wide band frequency or phase modulated telephony.
6 A4 — Amplitude modulated facsimile.

(b) On frequencies where wide band frequency or phase modulated telephony (40 F3) is authorized, narrow band frequency or phase modulated telephony (6 F3) may also be employed; similarly, where commercial quality amplitude modulated telephony (6 A3) is authorized, single or double sideband amplitude modulated telephony, with or without carrier or with reduced carrier, may also be employed.

§ 12.233. *Transmitter power.* The transmitting equipment of a radio station in this service shall be adjusted in such manner as to produce the minimum radiation necessary to carry out the communications desired. No station operating in this service shall use a direct current plate power input to the vacuum tube or tubes supplying energy to the antenna in excess of that permitted to be used by a licensed amateur radio station when operated on the same frequencies or in the same frequency bands in accordance with the provisions of the Rules Governing Amateur Radio Stations and Operators (Sub-Part A of this part).

§ 12.234. *Equipment requirements.* (a) Except under the conditions specified in paragraph (b) of this section, all stations authorized to be operated in the Radio Amateur Civil Emergency Service shall be capable of receiving on the same frequencies or frequency bands utilized for transmission.

(b) When a station in this service is operated only on a single frequency or frequency band for cross-band operation in communication with a station or stations operating on another frequency or in another frequency band, or in other services, such station shall be capable of receiving the station with which it is communicating.

(c) The direct modulation of an oscillator with a frequency stability less than that obtainable with crystal control, or the radiation of a signal having simultaneous amplitude and frequency or phase modulation, is prohibited on frequencies below 220 Mc after December 31, 1952.

§ 12.235. *Alleviation of harmful interference.* (a) When emissions of stations in the Radio Amateur Civil Emergency Service, other than those necessary to carry on the desired communications, cause harmful interference to stations in this or any other service, the Commission may, in its discretion, require appropriate technical changes in the equipment to alleviate the interference.

(b) When the emissions of stations in the Radio Amateur Civil Emergency Service that are necessary to carry on the desired communications cause harmful interference to stations in other radio services, appropriate action shall be taken to alleviate such interference including, if necessary, the suspension (except during times of an actual state of civil emergency) of such emissions as cause the interference.

OPERATING REQUIREMENTS

§ 12.241. *Operator requirements.* (a) No person shall operate a station in the Radio Amateur Civil Emergency Service unless (1) that person holds a valid radio operator license of the proper grade, as hereinafter described, and (2) that person holds a valid written certification by the chief of the local, regional, or state Civil Defense organization of the area in which he serves that he has satisfied all federal, state, and local requirements for enrollment in the Civil Defense organization as a radio operator and is actually enrolled therein. Such certification shall clearly indicate that a determination has been made as to his loyalty to the United States and general reliability in accordance with the procedures described in the approved civil defense communications plan for the area concerned. (See §§ 12.201 (i) and 12.212 of the Sub-Part.)

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[1] Use of frequencies in the band 1800–2000 kc. is subject to the priority of the Loran system of radionavigation in this band and to the geographical, frequency, emission, and power limitations contained in Section 12.111 of the Rules Governing Amateur Radio Stations and Operators (subpart A of this Part). The use of these frequencies by stations authorized to be operated in the Radio Amateur Civil Emergency Service shall not be a bar to expansion of the radionavigation (Loran) service, and such use shall be considered temporary in the sense that it shall remain subject to cancellation or to revision, in whole or in part, without hearing, whenever the Commission shall deem such cancellation or revision to be necessary or desirable in the light of the priority within this band of the Loran system of radionavigation.

(b) The person manipulating the key of a manually operated radiotelegraph transmitter of a station authorized to operate in this service shall hold either (1) any class of amateur operator license issued by the Commission, other than the Technician or Novice Class, or (2) any class of commercial radiotelegraph operator license issued by the Commission other than the Temporary Limited Radiotelegraph Second Class Operator License, together with the certification required in accordance with the provisions of paragraph (a) of this section.

(c) Except as specifically provided in paragraphs (a) and (b) of this section, any station in the Radio Amateur Civil Emergency Service may be operated by the holder of any class of amateur or commercial radio operator license issued by the Commission other than a Temporary Limited Radiotelegraph Second Class Operator License or an Aircraft Radiotelephone Operator Authorization; Provided, that, when such operation is performed by the holder of a Novice Class amateur operator license or by the holder of a commercial radiotelephone or radiotelegraph third class operator license or restricted operator permit: (1) such operator shall be prohibited from making any adjustments that may result in improper transmitter operation, (2) the equipment shall be so designed and installed that none of the operations necessary to be performed during the course of the normal rendition of the service of the station may cause off-frequency operation or result in any unauthorized radiation, and (3) any needed adjustments of the transmitter that may affect the proper operation of the station shall be regularly made by or under the immediate supervision and responsibility of the holder of either an amateur operator license other than the Novice class or a commercial radiotelephone or radiotelegraph first or second class operator license.

(d) All adjustments or tests during or coincident with the installation, servicing or maintenance of the transmitting equipment of a station in this service shall be made only by or under the immediate supervision and responsibility of the holder of either (1) an amateur operator license other than the Novice class or (2) a commercial radiotelephone or radiotelegraph first or second class operator license issued by the Commission who in addition holds the certification required in accordance with the provisions of paragraph (a) of this section.

§ 12.242. *Operation at other than licensed location.* A station in this service, or any unit thereof, may be operated at any location in accordance with the approved civil defense communications plan for the area concerned, in the discretion of and as directed by the Civil Defense Radio Officer, without notice to the Commission and without limitation as to the length of time within which such operation takes place: Provided, that nothing herein shall be construed to waive the necessity for modification of the authorization of a station in this service when the address of the licensee or the basic location of the station is changed, or for any other reason where because of a change of radio officer or of the communications plan or other reason the information heretofore furnished the Commission with the original application may be materially altered or changed.

§ 12.243. *Availability of station authorizations and operator licenses.* (a) The original station authorization permitting operation of the licensed amateur station in the Radio Amateur Civil Emergency Service, or a photocopy thereof, shall be permanently attached to each transmitter of such station, including each transmitter which is capable of being operated and intended to be operated independently at different locations, if the transmitter is readily accessible, or, if the control position is located at a place other than the transmitter location, it may be posted at the control position; Provided, that, whenever a photocopy of the station authorization is utilized in compliance with the foregoing requirement, the original station authorization shall be made available for inspection upon reasonable request from any authorized representative of the federal government.

(b) The original radio operator license, or a verification card (FCC Form 758-F) in the case of the holder of a commercial radio operator license of the diploma type, of the operator controlling the emissions of a station authorized to be operated in this service, together with the certification required by Sec. 12.241 (a) of this sub-part, shall be carried on his person or kept immediately available at the place where he is operating the station or any independent unit of a station; Provided, that, whenever a verification card (FCC Form 758-F) is utilized in compliance with the foregoing requirement, the original operator license shall be made available for inspection upon reasonable request from any authorized representative of the federal government.

(c) When a licensed amateur station, or an independent unit of such station, is operated at a location other than that shown in its license in compliance with the provisions of this Sub-Part, the basic amateur station license required by Sub-Part A of this Part need not be readily available at the station or unit location, but shall be made available for inspection upon reasonable request from any authorized representative of the federal government.

§ 12.244. *Radio station log.* (a) Except as otherwise expressly provided in these rules, there shall be maintained at each radio amateur civil emergency station, or unit of such station, an accurate log of all operations. The following information shall be recorded in such station log:

(1) The name and address of the station licensee, the regularly assigned call sign of the station and unit number if any, the name of the Radio Amateur Civil Emergency network or networks in which the station is normally operated, and the d.c. plate power input to the vacuum tube or tubes supplying energy to the transmitting antenna system. This information need be entered only once in the log unless there is a change in any of the above items, but the original entry and each change shall show the date on which the entry was made.

(2) The date and time of beginning and end of each period during which the station was operated, and the frequencies or bands of frequencies on which the operation took place.

(3) The call signs or other identification of all stations or units of such stations with which communications are established or attempted during such period of operation.

(4) The signature of the licensed operator on duty and in charge of the operation of the station or unit of such station during each period of operation, and the signature of each licensed operator who manipulated the key of any manually operated radiotelegraph transmitter of such station or unit. The signature of the operator shall be entered with the date and time at the beginning and end of each period during which he performed the foregoing duties, and at least once on each page additional to the first page, covering the period for which he was the responsible operator. The signatures of any additional operators who operate the transmitter(s) during the regular watch of another operator and details to indicate the periods during which they operated the transmitter(s) shall be entered in the proper form.

(5) Upon completion of each period of operation for any purpose, there shall be entered in the log a summary of such operation describing the nature thereof and, if message traffic or other record communications were exchanged with other stations, an estimate of the amount of such traffic handled together with a report on any unusual delays which were experienced in the delivery of such messages.

(6) There shall be no erasure, obliterations or destruction of any part of the log of any station or station unit. Corrections shall be made by striking out the erroneous portion and initialing and dating the corrections.

(b) Mobile radio amateur civil emergency stations or station units, and portable radio amateur civil emergency stations or station units, where not being operated at predetermined fixed locations, shall be exempt from the requirements of maintaining a log to the extent that the entries required under the preceding paragraph of this section are substantially contained in the log of another station or stations operating in the same radio amateur civil emergency networks. All stations or station units operating in accordance with the provisions of this subpart shall be exempt from the requirements concerning station logs contained in sub-part A of this Part whenever it is shown that compliance with these requirements would interfere with the expeditious handling of civil defense communications or communication drills.

(c) The current portion of the log shall be kept at the location of the operating or control position of the station or unit. Other portions of the log shall be retained by the licensee for a period of one year, at a place determined by the civil defense Radio Officer to be appropriate and advisable; *Provided*, that the logs of a station in this service shall be made available for inspection upon reasonable request by any authorized representative of the federal government; and *Provided further*, that those portions of any log covering operation of a station in this service in connection with any actual condition jeopardizing the public safety or affecting the national defense or security shall not be destroyed unless prior approval for such destruction shall have been received from the Commission.

§ 12.245. *Station identification.* (a) Stations operating in the Radio Amateur Civil Emergency Service shall identify themselves in the same manner and under the same conditions as prescribed in the Rules Governing Amateur Radio Stations and Operators (sub-part A of this Part), except that:

(1) Additional designators to indicate portable or mobile operation, or to indicate operation at a location other than that specified in the station license, shall not be used.

(2) When engaged in network operation, after a station or unit has been fully identified at least once, further identification by that station or unit may be accomplished by the use of abbreviated call signs or other distinctive signals prescribed by the civil defense Radio Officer in lieu of the call signs otherwise required to be transmitted by that station or unit. A record of such abbreviated call signs or other distinctive signals shall be maintained by the Radio Officer and shall be made available for inspection upon reasonable request by any authorized representative of the federal government.

(b) When two or more separate units of a station, which is authorized to be operated in the Radio Amateur Civil Emergency Service, are operated independently at different locations, each unit shall separately identify itself by the addition of a unit number at the end of its call sign. When transmitting by telegraphy such additional identification shall immediately follow the basic call sign and to avoid confusion with portable or mobile indicators, shall not be separated therefrom by the use of the "slant" or fraction bar, or other punctuation mark or symbol.

§ 12.246. *Tactical call signs.* Stations operating in this service, and independent units of such stations, may be assigned tactical or secret call signs by the Commission or by competent civil defense authority, and may utilize such tactical call signs in lieu of the call signs appearing on the station licenses when such use is directed by competent civil defense authority; *Provided*, that a list of all such tactical call signs assigned stations under his direction shall be maintained by the civil defense Radio Officer and shall be made available for inspection upon reasonable request by any authorized representative of the federal government; and *Provided further*, that when such tactical call signs are intended to be used at times other than during communications in connection with actual or impending conditions which appear to jeopardize the defense or security of the United States, a list of such tactical call signs and the stations or units to which assigned shall be furnished the Commission prior to such use.

USE OF STATIONS

§ 12.251. *Limitations on use of stations.* (a) No station authorized to be operated in this service, other than a control station as defined in this Sub-Part, shall be operated for the purpose of transmitting any signal, message, or other communications except with the permission and under the operational control of the control station of the network in which it is operating: *Provided*, that nothing in the foregoing shall be construed to prohibit the transmission by any station or unit of a station of such signals as may be necessary for the purpose of alerting or making contact with the control station of the network, or for the purpose of transmitting actual emergency civil defense communications if the control station is disabled or is otherwise inoperative.

(b) Nothing in this section shall be construed to prevent the operation of a station which is authorized to be operated in this service for the purpose of brief tests or adjustments during or coincident with the installation, servicing or maintenance of such station: *Provided*, that the transmissions of that station during such tests or adjustments shall not cause harmful interference to the conduct of communications by any other station.

(c) No station in this service shall be used to transmit or to receive messages for hire, nor to transmit communications for material compensation, direct or indirect, paid or promised.

§ 12.252. *Hours of operation.* Stations in this service may be operated at such times and under such conditions as may be prescribed by the Communications Officer or other responsible official of the civil defense organization having jurisdiction over the area which the station will serve provided that the communications of such stations shall at all times be in accordance with the permissible communications authorized in this sub-part.

§ 12.253. *Points of communication.* Stations in this service may communicate with each other, with stations in the Disaster Communications Service and with stations of the United States government which are authorized to exchange communications with stations in this service by the particular agency having control. In addition, stations in this service may communicate, for the purpose of exchanging civil defense communications, with any other station in any service provided by the Commission's Rules whenever such station is authorized to communicate with stations in the Radio Amateur Civil Emergency Service by the provisions of the Commission's rules governing the class of station concerned or in accordance with the provisions of Section 2.405 of Part 2 of the Commission's rules.

§ 12.254. *Permissible communications.* Stations in this service are authorized to transmit only the following types of civil defense communications:

(a) Communications for training purposes; necessary drills and tests to insure establishment and maintenance of orderly and efficient operation of the radio networks and such other radio stations and networks as may be associated therewith for the conduct of civil defense communications, including communications directly concerned with the conduct of practice alerts, practice blackouts, practice mobilization and other comparable situations as may be ordered or initiated by competent civil defense authority or by the U. S. Governmental or military authority charged with the defense of the area concerned. All messages which are transmitted in connection with such drills and tests shall be clearly identified as such by the use of the words "Drill" or "Test" in the body of such messages.

(b) Communications when there is an impending or actual condition jeopardizing the public safety or affecting the national defense or security:

(1) Communications directly concerning the activation of the radio amateur civil emergency station networks or such other radio stations and networks as may be associated with the networks for the conduct of civil defense communications.

(2) Communications directly concerning the conduct of service by the radio amateur civil emergency networks and such other radio stations and networks as may be associated therewith.

(3) Communications directly concerning safety of life, preservation of property, maintenance of law and order, alleviation of human suffering and need, and combating of armed attack or sabotage.

(4) Communications directly concerning the accumulation and disseminiation of public information or instructions to the civilian population essential to the activities of the civil defense organization or that of other authorized governmental or relief agencies.

(5) Communications directly concerning the transaction of business essential to public welfare.

§ 12.255. *Use of codes and ciphers.* Any station in this service is authorized to transmit messages in codes and ciphers and to utilize any method of secret or coded authentication of its transmissions when such method of concealing the contents of messages or such authentication procedure is prescribed by the competent civil defense authority of the area served by the station and is approved by the cognizant federal civil defense authorities.

§ 12.256. *Priority of communications.* The order of priority of communications by stations in this service, when there is an impending or actual condition jeopardizing the public safety or affecting the defense or security of an area, shall be determined by the cognizant civil defense authority of the area concerned or his authorized representative.

§ 12.257. *Operating procedure.* The operating procedure, and the method of circuit control by the control station of each network, shall be determined by the responsible civil defense authority of the area concerned and shall, in general, conform as nearly as possible to the operating procedure normally followed in other services in the expeditious handling of message traffic by the method of transmission in use.

U. S. – Canada Reciprocal Operating Agreement

The Governments of the United States and Canada have worked out an agreement whereby amateurs of one country may operate in the territory of the other. The authority for reciprocal operating privileges comes from a treaty with the extensive title, "Convention Between the United States of America and Canada, Relating to the Operating by Citizens of Either Country of Certain Radio Equipment or Stations in the Other Country."

In its entirety, the treaty provides for such matters as the operation by civilian pilots of the radio gear in aircraft of the other country's registry and the use of commercial radio-telephone mobile units in border areas on both sides of the boundary. And it provides that "Amateur wireless operators will be permitted, subject to certain conditions, to use their wireless sets while visiting the other country."

We quote Article III of the treaty, dealing with amateur operations:

ARTICLE III

It is agreed that persons holding appropriate amateur licenses issued by either country may operate their amateur stations in the territory of the other country under the following conditions:

(a) Each visiting amateur may be required to register and receive a permit before operating any amateur station licensed by his government.

(b) The visiting amateur will identify his station by:

(1) Radiotelegraph operation — The amateur call sign issued to him by the licensing country followed by a slant (/) sign and the amateur call sign prefix and call area number of the country he is visiting.

(2) Radiotelephone operation — The amateur call sign in English issued to him by the licensing country followed by the word "fixed", "portable" or "mobile", as appropriate, and the amateur call sign prefix and call area number of the country he is visiting.

(c) Each amateur station shall indicate at least once during each contact with another station its geographical location as nearly as possible by city and state or city and province.

(d) In other respects the amateur station shall be operated in accordance with the laws and regulations of the country in which the station is temporarily located.

U. S. amateurs wishing to operate in Canada should write to Radio Division, Department of Transport, Ottawa, Ontario, Canada, stating their desire to operate in that country, giving their complete name and call letters, and outlining very briefly the nature of the trip and approximate dates. You should write several weeks before your contemplated trip. In reply you will receive two copies of an application form. Since the same application form is used for radio services other than amateur, a space is provided for "license number." Amateurs should leave this space blank. These are to be filled out carefully and mailed back to Ottawa. If all is in order, the duplicate copy will be authenticated and mailed back to you. This copy, *plus your FCC license,* will comprise your authorization to get your gear through customs and operate in Canada.

Canadian amateurs desiring to operate in the United States should follow the same application procedure, except in this case a bit more advance notice might be given, and application should be made to Authorization Analysis Division, Federal Communications Commission, Washington 25, D. C.

Note that the treaty requires that amateurs operate in accordance with the laws and regulations of the country in which the station is temporarily located. Particular care should be taken to familiarize one's self with amateur bands, especially 'phone suballocations. Canadian amateurs may refer to page 43 of September, 1953, *QST* for an up-to-date listing of U. S. amateur allocations.

In Canada, the 1800–2000 kc. band is divided into segments as follows: Ontario and east have 1800–1825 and 1875–1900 kc., 250 watts day and 100 watts night; Manitoba and west have 1900–1925 and 1975–2000 kc., same power limits.

In addition to the above, 'phone suballocations in Canada are:

3725–4000 kc.
7200–7300 kc.
14,150–14,350 kc.
21,200–21,450 kc.
26,958–27,282 kc.
28,200–29,700 kc.

Note the over-all 11-meter band limits in Canada are 26,958–27,282 kc. Also, the power limit in Canada, with the exception of the indicated limits for 1800–2000 kc., is 500 watts *in the antenna,* based on a final amplifier efficiency of 70 per cent.

Canadians are reminded that monthly notification must be given the U. S. Engineer in Charge of the district in which temporary operation is contemplated. The notice should state call letters, name, dates of proposed operation, and portable location or mobile itinerary; it should also make reference to the authorization issued by the FCC in Washington.

FCC licensees operating outside the continental limits of the U. S. are required to notify the Engineers in Charge of their home FCC districts if such operation will be for more than 48 hours.

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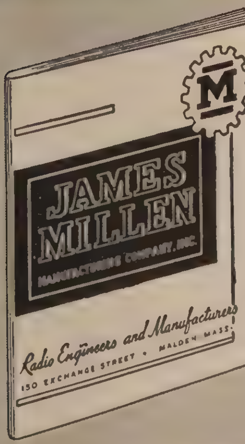
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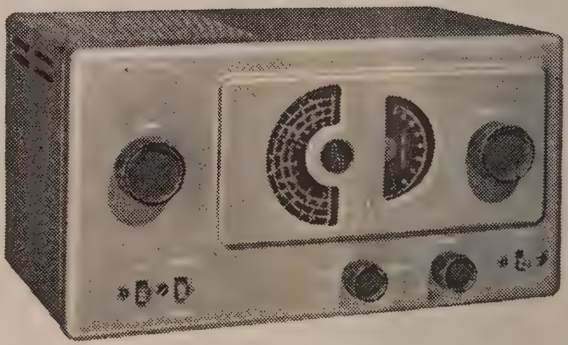

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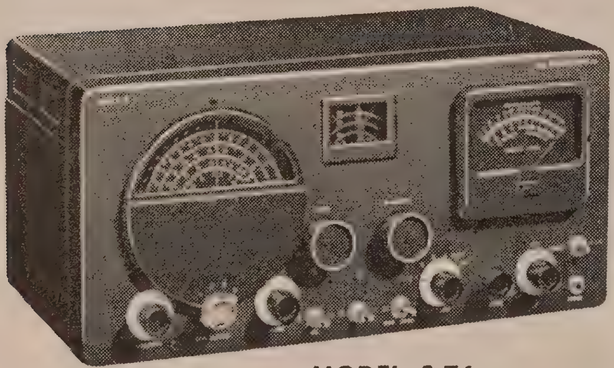

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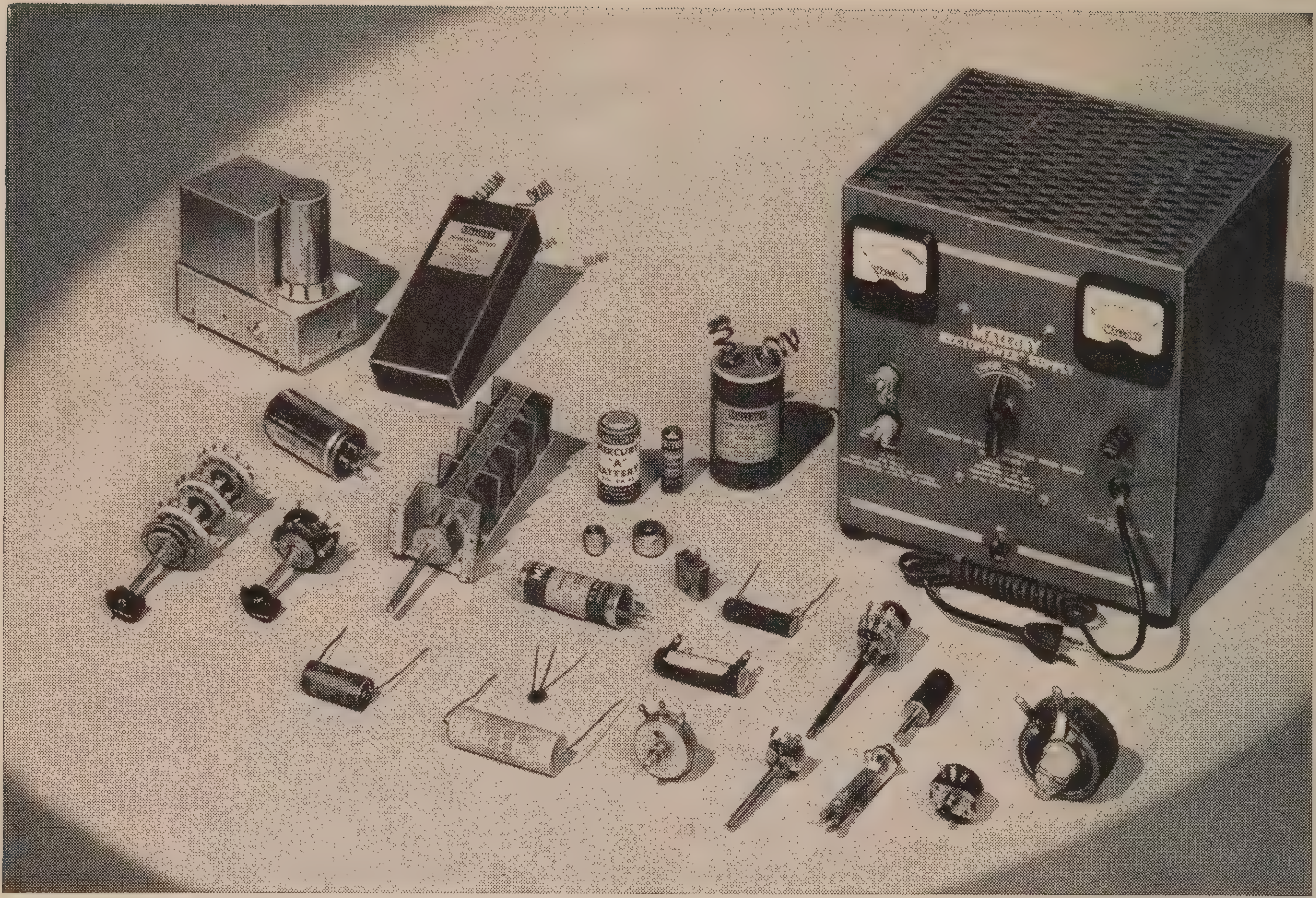

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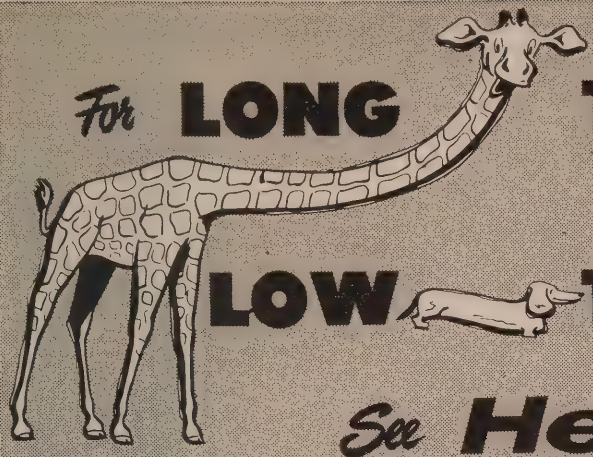

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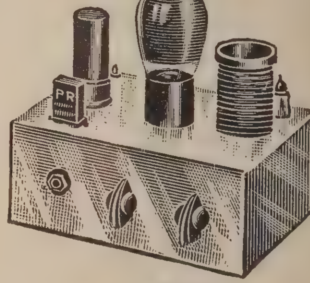

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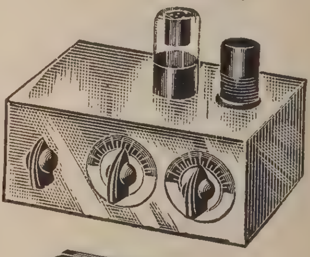

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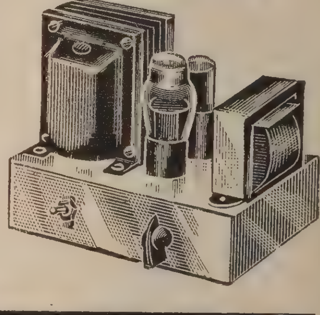

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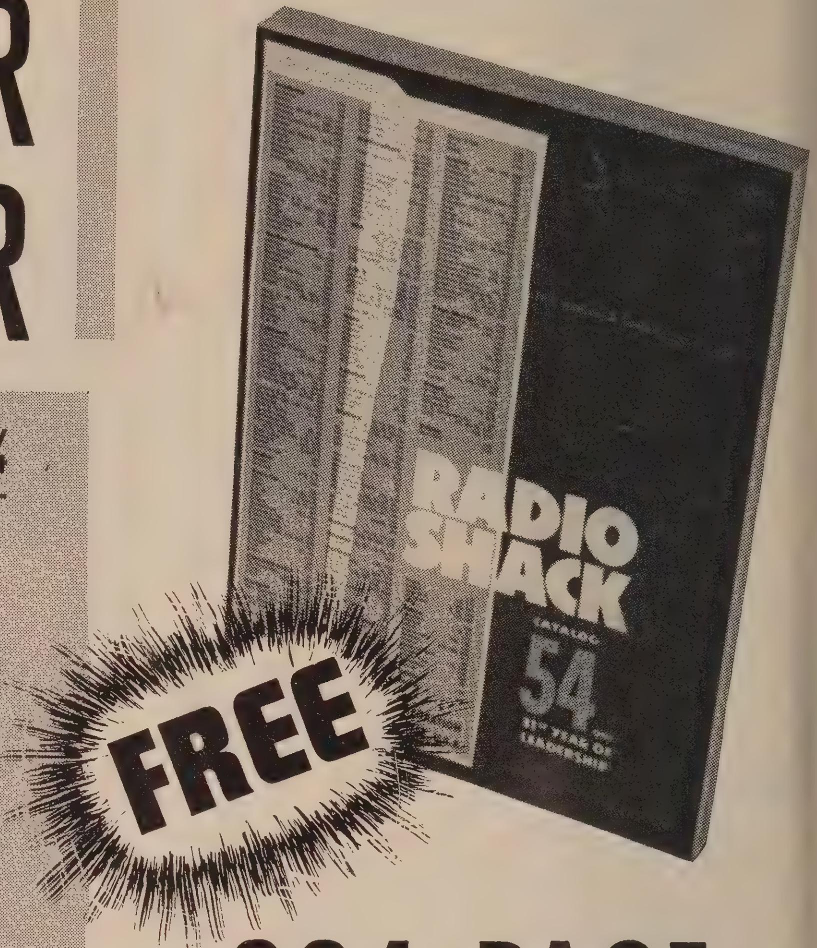

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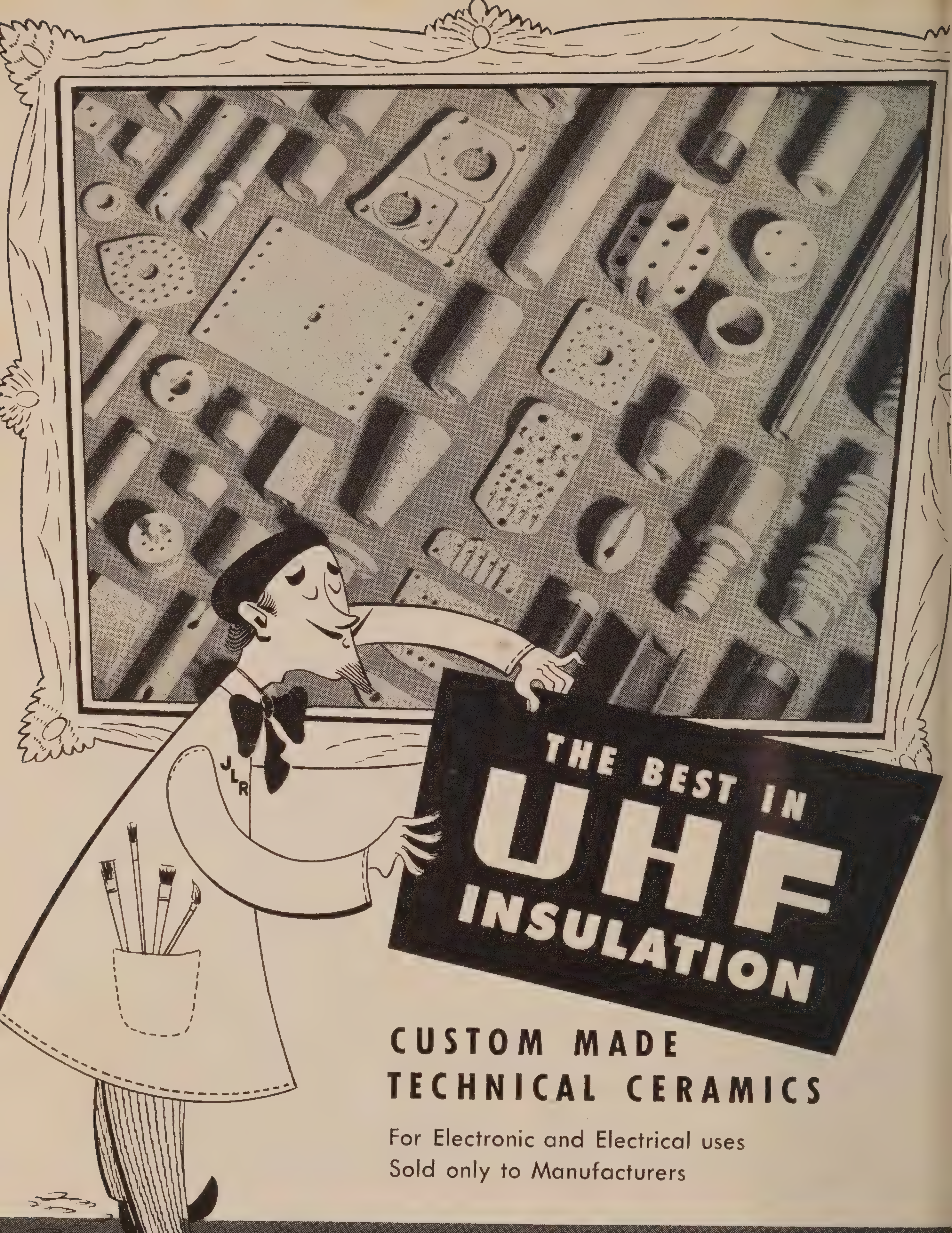
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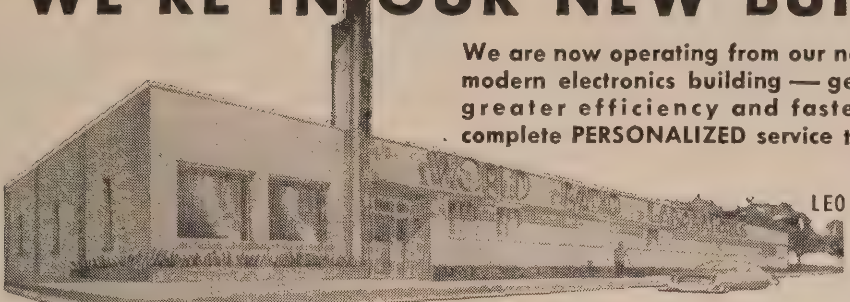

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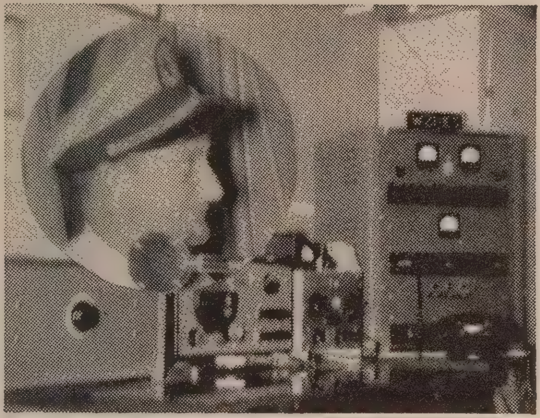

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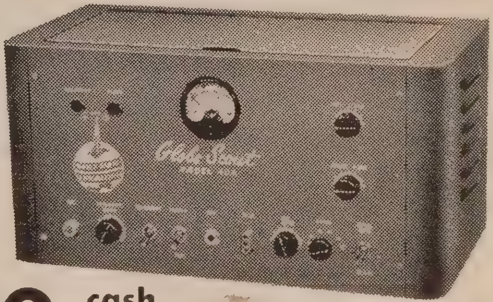

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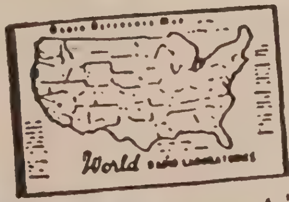

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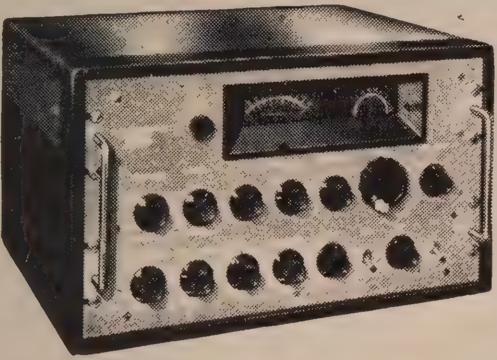

Model HT-20. T.V.I. suppressed 100 watt AM-CW transmitter with all spurious outputs above 40 Mc at least 90 db. below full rated output.

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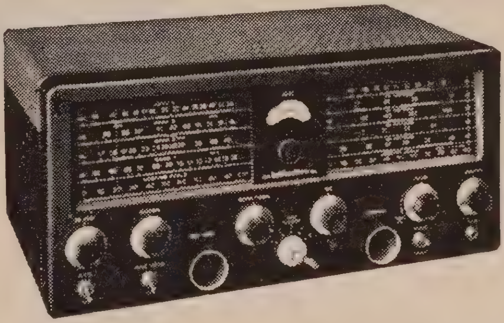

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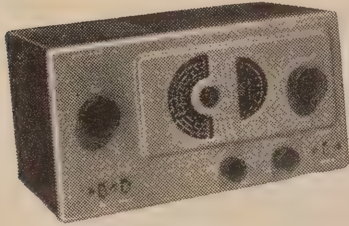

Model S-40B Receiver
Excellent sensitivity. Covers 540 kc to 43 mc — including standard broadcast and amateur bands. Tuning dial calibrated for 5 bands. 5'' PM speaker. Phono jack. Tubes: 6SG7 RF; 6SA7; 2-6SK7s; 6SC7; 6K6GT; 6H6; 5Y3GT rectifier. Black finish steel cabinet. 18½x8⅞x9½''. 105-125 volts, 50-60 cycles AC. Complete with tubes. Shipping wt., 33 lbs.
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Model S-38C Receiver
Wide-Range. 540-1650 kc (standard broadcast); band 2, 1.65-5.1 mc; band 3, 5-13.5 mc; band 4, 13-32 mc. Tubes: 12SA7, 12SG7, 12SQ7, 50L6-GT. Has 35Z5GT rectifier. Size, 12⅞ x 7 x 7¾''. 105-125 volts, 60 cycles AC or DC; also 210-250 volts AC or DC with line cord below. With tubes. Wt., 14 lbs.
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98F013. Wt., 6 oz. **NET**......**2.00**

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Model SW-54 Receiver
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JOHNSON KEYS

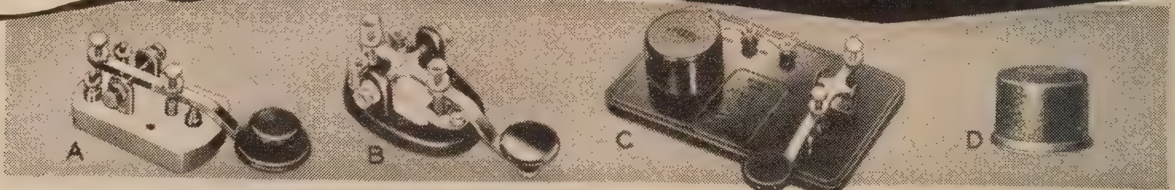

Fig. A. Heavy Duty Keys. Heavy die cast base, chrome plated key arm. Well insulated for heavy duty service. Large ¼'' coin silver contacts. Navy type knob. Adjustable steel bearings and spring designed to give a light keying touch. Wt., 2 lbs.
27F531. Type 114-320. Black wrinkle base.
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Fig. B. Standard Keys. Heavy die-cast base. Smooth adjustable bearings. ⅛'' coin silver contacts. With switch. Wt., 2 lbs.
27F528. Type 114-310S. Black wrinkle base.
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Fig. B. Phenolic Base Key. Adjustable bearings, improved spring, ⅛'' coin silver contacts. Less switch. Nickel-plated. Wt., 2 lbs.
27F518. Type 114-301. **NET**..........**1.95**

Fig. C. Practice Set. Constant frequency buzzer and key on 4x6'' brown bakelite base. May be used singly or in pairs. Wt., 1 lb.
27F517. Type 114-450. **NET EACH**..........**3.95**

Fig. D. Constant Frequency Buzzer. Black bakelite base and cap. Fully adjustable. Coin silver contacts. Uses 2 dry cells or ''C'' battery. Less batteries. Wt., 1 lb.
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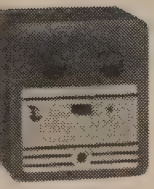
JOHNSON SIGNAL SENTRY

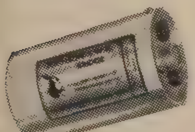


Designed for monitoring either CW or phone signals without regard to operating frequency, the JOHNSON Signal Sentry is energized by transmitter RF. Receiver audio muted for break-in operation. Unit may be used as a code practice oscillator, with slight modification. Size: 3⅞"x3⅝"x3¾". Tubes required, but not furnished: one 12AX7 and one 12AU7. Weight: approx. 3 pounds. **250-25 Johnson Signal Sentry, completely assembled, less tubes; installation instructions included. $14.70 AMATEUR NET.**

VIKING VFO

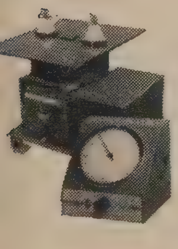
Accurately calibrated for all amateur bands from 10 to 160 meters. Excellent stability, vernier tuning, clean keying, and perfect "break-in" on all bands. **240-122 Viking VFO kit complete, less tubes, $42.75 Amateur Net. Available wired and tested, $63.75 Amateur Net.**

SWR BRIDGE



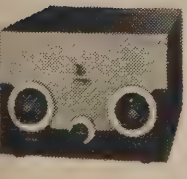
Provides accurate measurement of standing wave ratios to insure most effective use of a low pass filter and antenna coupler for ultimate in TVI suppression. 52 ohms impedance can be changed to 70 ohms or other desired value. Equipped with SO-239 connectors and polarized meter jacks. **250-24 SWR Bridge, $9.75 Amateur Net.**

JOHNSON ROTOMATIC ROTATOR



All-weather antenna rotator designed for rugged service. Light weight cast aluminum housing with 5/16" steel rotating table. Unit tilts for simplified beam adjustment. Safely supports dual beams weighing up to 175 pounds. Reversible 360° rotation. Slip rings handle up to 2½ KW. Assembly includes control box with selsyn operated, illuminated dial. Controls, rotation switch, power switch and antenna relay switch. **138-112 Johnson Rotomatic Rotator, $324.00 Amateur Net.**

JOHNSON "MATCHBOX"



"Matchbox" loads an almost infinite variety of antennas from 3.5 to 30.0 mcs. Matches balanced antennas from 25 to 1200 ohms resistance. Loads unbalanced, or single wire antennas of approximately 25 to 3000 ohms resistance. Tunes out large amounts of reactance. Self-contained antenna changeover relay. Bandswitching—front panel controls—no internal adjustment required to change bands. **250-23 Johnson "Matchbox", assembled, wired, tested, $49.85 Amateur Net.**

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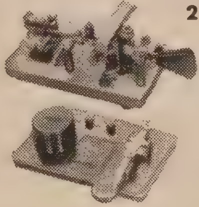
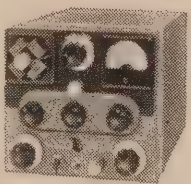
A diminutive variable frequency oscillator designed specifically for mobile use. Compensated for an extremely wide range of ambient temperatures, the JOHNSON Mobile VFO is only 4"x4¼"x5". Output is sufficient to drive any straight pentode crystal stage as an amplifier. Circuit design, rigid construction, and heavy aluminum cabinet minimize frequency shift due to road shock and vibration. Tube line-up consists of a 6BH6 oscillator, 6BH6 isolation amplifier/frequency multiplier, 0A2 voltage regulator. **250-152 Viking Mobile VFO in complete kit form, less tubes; assembly and operating instructions included $29.45 AMATEUR NET. Available factory assembled, less tubes; wired and tested, 250-152-2. $44.95 AMATEUR NET.**

JOHNSON KEYS



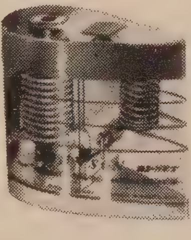
Practice sets, semi-automatic, standard, and practice keys. Semi-automatic models adjustable from lowest to highest speeds. Standard and practice keys feature coin silver contacts and operate with a light keying touch. **$1.45 to $21.00.**

VIKING MOBILE KIT



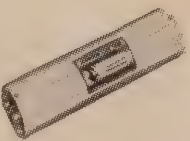
Power packed mobile. 807 amplifier, 60 watts maximum input, 100% amplitude modulated with PP807's. Gang-tuned, bandswitching, 5 bands (75, 40, 20, 15 and 10) with VFO provision. Series tuned output links . . . solve loading problems. Dash mounting—easily accessible—illuminated meter. **240-141 Viking Mobile Kit Complete, less tubes, microphone, power supply and antenna, $99.50 Amateur Net. Also available wired and tested.**

JOHNSON BI-NET



Dual mobile antenna loading network for 10 and 20 meter amateur bands. Mounts in center of standard mobile whip—enables operator to change bands in motion. Operation is completely automatic, no relays or mechanical control required. After initial adjustment, BI-NET requires no further attention. Enclosed in streamlined, weatherproof plastic housing—equipped with ⅜"x24 female threads for antenna mounting. Size, 4 7/16" high, 5 5/16" long, 2⅜" width, weight 14 oz. **250-22 Johnson "Bi-Net" $10.95 Amateur Net.**

LOW PASS RF FILTER



Consists of four individually shielded sections, capable of handling more than 1000 watts amplitude modulated RF. Provides 75 db harmonic attenuation in the antenna circuit. SO-239 coaxial connectors, assembled and pre-tuned. **250-20 Low Pass RF Filter, $16.50 Amateur Net.**

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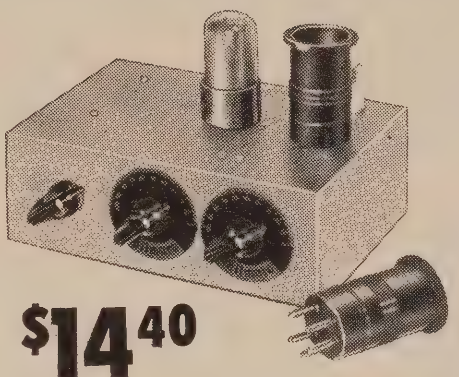

$14.40

Model NR-300. Operates with Philmore Novice Transmitter as well as other popular models. It's easy to assemble, and makes a highly sensitive receiver covering the 15, 40 and 80 meter bands. Supplied complete with step-by-step instructions, pictorial and schematic diagrams, and coil forms and wire for 40 and 80 meter bands.

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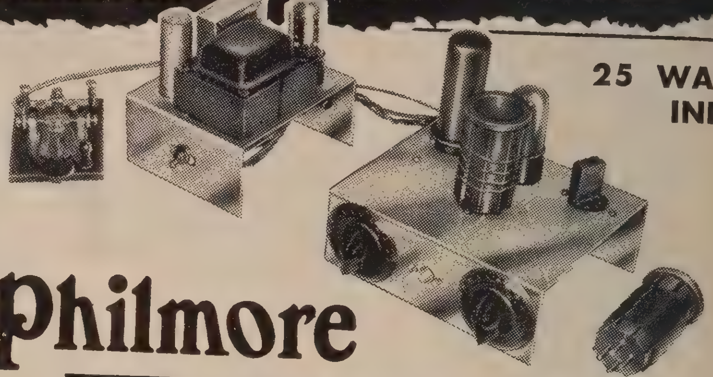

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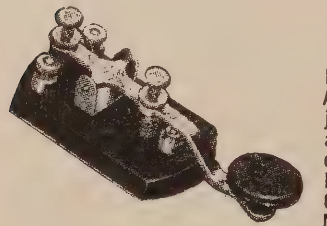
This kit is supplied with tubes, standard key, and complete step-by-step instructions, including testing and operating.

Model NT-200 .... Amateur Net Price **$29.40**

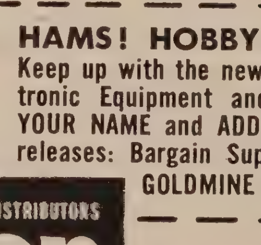


JOHNSON PRACTICE KEYS

Inexpensive, ideal for beginners. All metal parts nickel plated. Adjustable key arm spring, smooth action bearings, 1/8" coin silver contacts. Molded brown phenolic Base.

Cat. No. 114-300

Net Price **$1.85**



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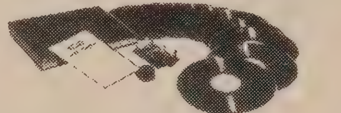

Learn code quickly and easily. These records are for use with standard 78 RPM phonograph. **Junior Set** (ideal for those planning to take Novice or Technician Amateur examination). Code speeds from start to 7½ words per minute **$7.95**

Senior Set (to 18 Wpm).. $12.95

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Register Now at any of our three stores! Come in Today!

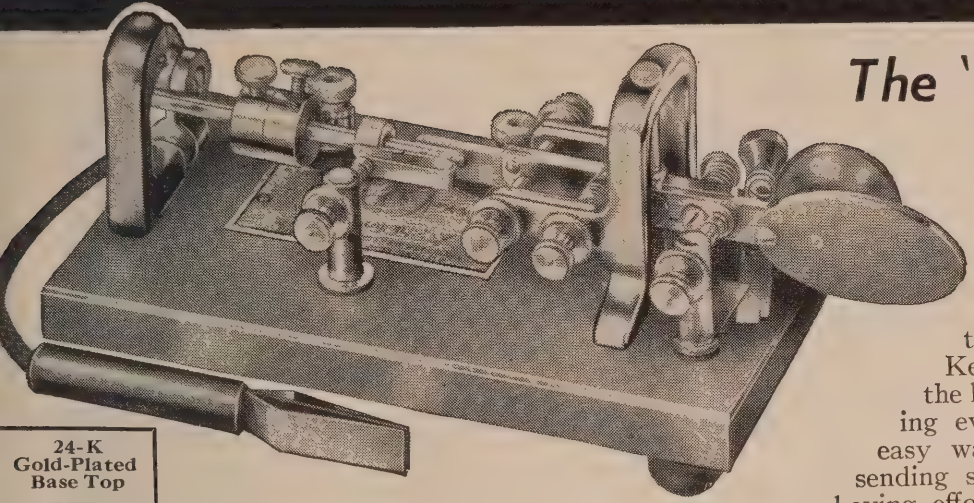
You'll key easier . . . better . . . faster with

Twice as easy as hand sending

VIBROPLEX

Semi-Automatic Key

The "BUG"

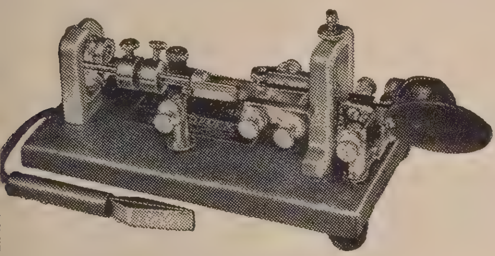


24-K Gold-Plated Base Top

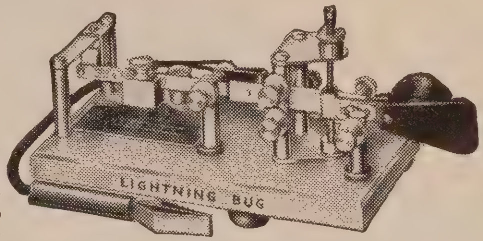
Nothing has contributed so much to keying ease as the Vibroplex Semi-Automatic Key. It offers the very easiest, the least tiring method of operating ever devised. It provides an easy way of acquiring a pleasing sending style and saves up to 60% keying effort. No special skill needed, no arm-tiring effort involved.

The "PRESENTATION" — This great new super deluxe ey is the best-looking key to be found anywhere, and the asiest to use. In addition to other Vibroplex features, this ey has an **exclusive super-speed control mainspring** hat provides wider speed range, and operates at slowest peed without extra weights. Polished chromium parts, red rim, 24-K gold-plated base top, jewel movement . . . **$29.95**

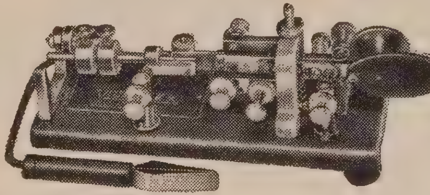
Standard —
Black crystal base
DeLuxe —
Polished chromium base and parts, red trim, jewel movement
All models equipped with 3/16" contacts



The "LIGHTNING BUG" — A popular key, moderately priced. Many exclusive features contributing to greater keying enjoyment, including a flat pendulum bar, slotted weights, adjustable dot contact spring, bridged damper frame and others. Maintains uniform signals at all speeds. Complete with circuit closer, cord and wedge, Standard, **$15.95**; DeLuxe, **$21.50**.

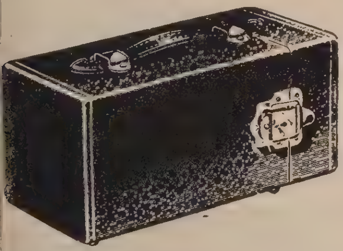


The "ORIGINAL" — This famous all-purpose ey has won international fame for signal uality, ease of operation and all-around keying xcellence, by thousands of the world's finest perators. Complete speed range. Built for long ife and rough usage. Complete with circuit loser, cord and wedge, Standard, **$17.95**; DeLuxe, **$22.50**.



The "BLUE RACER" — Small, compact, handy. Built extra sturdy like the Original, but only half the size. Wt. 2 lbs. 8 oz. Takes about as much desk space as blotter. Has all the operating advantages of the large models. Complete with circuit closer, cord and wedge, Standard, **$17.95**; DeLuxe, **$22.50**.

All Vibroplex keys are available for left-hand operation, one dollar more



CARRYING CASE — Black, simulated morocco. Cloth-lined. Reinforced corners. Flexible leather handle. Handy to carry. Protects key from dust, dirt and moisture, and insures safe-keeping when not in use. With lock and key, **$5.75**.

Avoid imitations!
The **"BUG"** Trade Mark
identifies the
Genuine Vibroplex
Accept no substitute

NEW SPECIAL ENLARGED Edition of PHILLIPS CODE, $2.00 Postpaid

Also includes:
Radio Code Signals
International Morse
American Morse
Russian, Greek, Arabic, Turkish and Japanese Morse Codes
World Time Chart
United States Time Chart
Commercial "Z" Code
Aeronautical "Q" Code
Miscellaneous Abbreviations. Used on international wire, submarine cable and radio telegraph circuits.

Vibroplex keys are designed to meet exacting operating standards, and to provide trouble-free long life service for the user. At dealers or DIRECT. FREE descriptive folder.

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W. W. ALBRIGHT, *President*
IF YOU SEND YOU SHOULD USE A VIBROPLEX KEY

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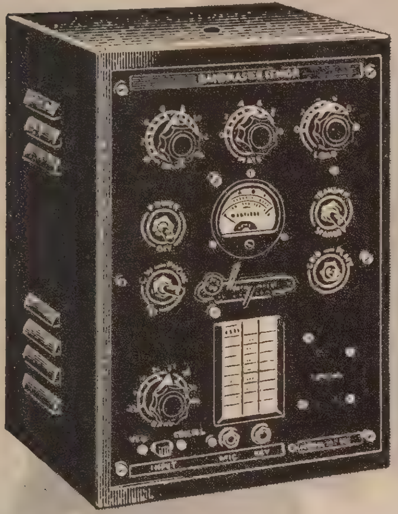
BANDMASTER & ACCESSORIES

ENGINEERED SPECIFICALLY FOR THE VERSATILE HAM

40 to 50 Watts — 8 Bands — Phone or CW
NO PLUG-IN COILS

80, 40, 20, 15, 11, 10, 6 and 2 Meters
(completely wired and tested—not a kit)



BANDMASTER SENIOR

A complete ready to go transmitter including the new crystal-oscillator-vfo switching circuit. Phone or CW — Eight bands — 80, 40, 20, 15, 11, 10, 6 and 2 Meters. Ideal for either mobile or fixed station use. Will operate from A.C. power packs up to 450 volts at 275 ma. vibrator supply or dynamotor supply for portable mobile operation. Employs Pi antenna matching network. Power input to final is 50 watts with 450 volt power supply on Bands 1 through 7, 30 watts on Band 8. No tuning adjustments are necessary except those required to resonate the final output to the antenna. May be mounted on rack panel with power supply. For use with carbon microphone. No plug in coils .. **$111.50**

BANDMASTER DELUXE

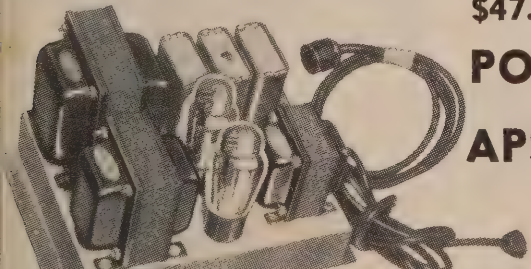
Has built-in three tube preamplifier for use with crystal mike, and ALL the features of the Bandmaster Sr. **$137.50**

THE NEW BANDMASTER V F O

Designed specifically for the Harvey-Wells Bandmaster, but may be used with all types of transmitters. Extremely stable — both electrically and mechanically — rugged tests produce no loss of power or frequency shift even on 28 mc. Slanted, illuminated dial face provides ease of operation and full visibility. Cabinet styled specifically to save valuable space in the shack. Your Bandmaster and VFO become an integral unit. 300 ohm output plugs into crystal socket. The Bandmaster VFO has been designed to meet the flexible requirements of today's versatile amateur. Six bands — each directly calibrated on the oversize slide rule dial — provides 30-35 volts R.F. output over entire frequency range, measured across the 6AQ5 in the transmitter oscillator — Plate and heater voltages are obtained from the terminal strip on the transmitter. Power requirements are 6.3 v @ 0.65 amps. and 300 v @ 30 ma. Highly stable Clapp type oscillator circuit uses 6AG7 and OB2 voltage regulator. **$47.50**

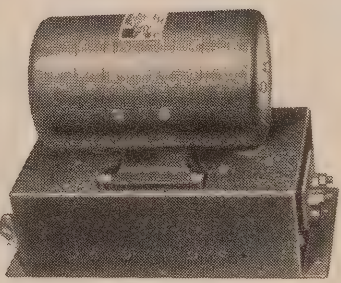
POWER SUPPLIES

APS-50



Delivers 425 v. at 275. ma. and 6.3 v. at 4 amps. May be mounted on rack panel. For 110 Volt A.C. 50-60 cycles **$39.50**

DPS-50



A dynamotor supply for portable operation. Delivers 300 Volts 250 ma.

For 6 Volt operation	**$87.50**
For 12 Volt operation	**54.50**

(400 Volts 250 ma.)

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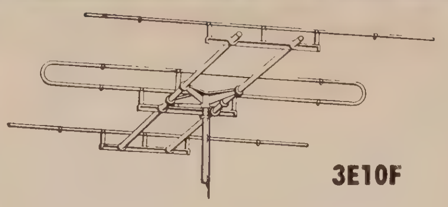
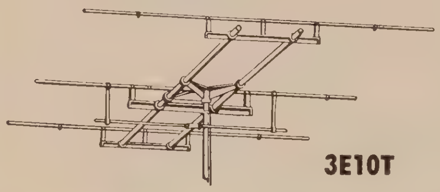
HY-LITE AMATEUR ANTENNAS



3E10F



3E10T

THE FAMOUS INSULATED STANDARD

6, 10-11, 15, 20 METERS • 2, 3, 4 ELEMENTS

Quickly and easily assembled, the HY-LITE ROTARY BEAMS are ideal for any transmission location. They are built ruggedly and will stand up under stress and strain far beyond that encountered under actual use.

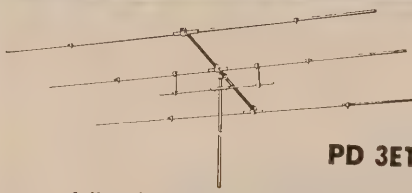
The elements on the 6, 10-11 mtr. beams are made of ⅝" and ¾" telescopic aluminum tubing of the highest grade. (The elements of the 15 & 20 mtr. beam are of 1" and ⅞" tubing,) with locking clamps for securing after tuning. The elements are supported on heavy Steatite insulators. Strong aluminum castings support the reflectors and directors and the antenna elements.

The HY-LITE ROTARY BEAMS are rigid and sturdy and mounted on a standard size 6' mast.

Any BEAM can be purchased and later a BEAM of a different frequency added to the original. Stacked array can be had in any combination on order.

6, 10 & 15 meter beams supplied with .1 and .15 spacing. 3 element 20 meter units supplied with .075 & .1 spacing.

FULLY ADJUSTABLE • ALL ALUMINUM • PRICED RIGHT



PD 3E10

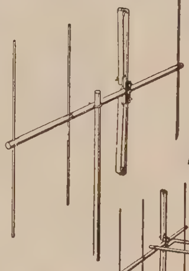
THE ALL-GROUNDED SKY-LITE

6, 10-11 METERS • 2, 3 ELEMENTS

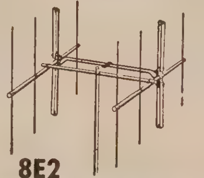
Lightest Beam ever built by HY-LITE. Beam complete includes Mast. Can be assembled and adjusted in less than 30 minutes by one man with only a screw driver. Element lengths and spacing fully adjustable. Will withstand high winds and gale, built of all dural tubing and rigid aluminum castings. Elements are ¾" and ⅝" diameter, boom is heavy wall 1". "T" match is adjustable by movable castings to match 300 ohm line. So light it can be rotated with almost any TV antennae rotator. Completely grounded. Good lightning protection. No wood used. Good forward gain and front to back ratio. Very little sag in either boom or elements. Using .1 and .15 spacing. 6 meter or 10 meter can be added separately at later date for stacking. Full instructions are given for length of elements and spacing at different frequencies.

WATCH OUR ADS IN QST FOR CURRENT PRICES

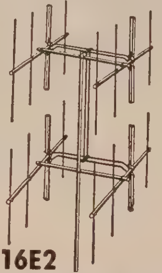
2 meter arrays



4E2



8E2



16E2

Can be mounted for horizontal polarization, built of all dural tubing. All elements are grounded. Excellent forward gain and front to back ratio. Boom is 1" diameter hard tubing. Using .2, .2, and .25 spacing. Elements are ⅜" and 1" outside diameter. Unit is supplied with clamp to fit any size mast up to 1⅜ inch outside diameter (no mast is included with unit.) So light it can be rotated with almost any TV Antennae Rotator. Each four element unit weighs under 3 lbs. — 16 Element unit weighs approximately 12 lbs. Made to match 300 ohm line. Can be stub matched for use with low impedance coax.

A FULL LINE OF

UHF-VHF

FM-TV

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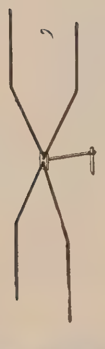
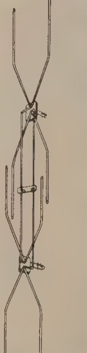


QUADRAPOLE *OR THE NEW* ROCKETQUAD



HIGH GAIN • OMNIDIRECTIONAL • CD • POLICE • FIRE • HAM

These famous revolutionarily designed antennas are the design of 'Doc' Ross, W2NGA. Real gain is offered over a ground plane and conventional type all-direction antennas. Featuring the same all aluminum construction for which HY-LITE is famous, the QUADS are ideal for service other than, as well as, amateur; CD Headquarters, Police Stations, Fire Stations, Aircraft towers or any application where omnidirectional signals with added gain is desirable. Impedance at antenna is approximately 300 ohms but instructions for balun matching for 52 or 72 ohm coax is included. QUADRAPOLE owners can obtain an additional QUAD and matching stub to assemble the ROCKET QUAD at reasonable cost. Complete with all hardware less mast.

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HY-LITE *Antennae* Inc., 243 EAST 137th STREET, NEW YORK 51, N. Y.

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73,

Bil Harrison, W2AVA

CODE PRACTICE
OSCILLATOR AND MONITOR

Excellent code practice oscillator. Later, use it to monitor your CW or phone xmtr.) Ideal for home or club code practice groups. Has built in speaker and may be used with up to 20 pairs of earphones. Any number of keys may be connected in parallel. Has volume and pitch controls. External speaker may be plugged into phone jack. Grey hammertone finish. 115 v. AC-DC. 6½" x5½"x3½".

BUD CPO-128 CODEMASTER $15.43

ECONOMY CODEMASTER—Same as above, without built-in speaker. Phones or speaker may be plugged-in.

BUD CPO-130 .... $13.82

Learn... Code and Theory This Easy Low Cost Way

Ameco Home Study Theory Course. Covers Novice, Technician, General Conditional and Advanced classes. 14 separate study sections cover basic electricity thru radio transmission and reception. Easy to understand with pictures and diagrams. Sample FCC exams and questions. Study guides show you how to study $6.95

CODE COURSES—Double-faced, 78 rpm records, teach code by actual sound, then give FCC type exams. With album and instruction book:

NOVICE CLASS. 5 records, Alphabet thru 8 words per minute $7.95

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COMBINATION OFFER.
All above 11 records in album ... $12.95

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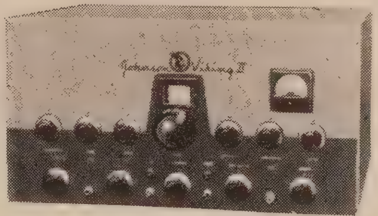
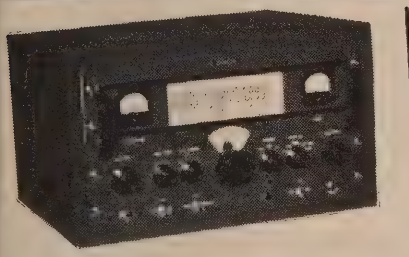


Famous VIKING II

Fully shielded, filtered and TVI suppressed. 180 watts CW input, 135 watts phone Covers all bands from 10 to 160 meters. New 6146 final gives high efficiency at lower cost. With tubes, cabinet, detailed assembly, wiring and operating instructions. Less crystals, key and mike.

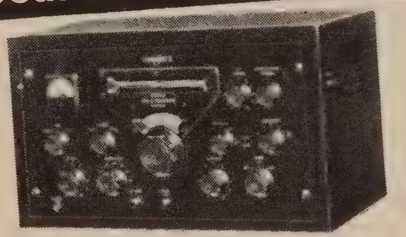
Complete Kit	$279.50
Laboratory Wired & Tested	$337.00

Famous COLLINS Gear for Amateurs



COLLINS 32V-3 XMTR

Compact, VFO controlled, gang-tuned unit with complete band-switching. 150 watts input on CW, 120 watts on phone. Covers all ham bands: 80 thru 10 meters. Permeability tuned circuits. Added TVI suppression features. The most wanted of all medium power xmtrs!
In Stock! $775.00



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Featuring sensational new Collins mechanical IF filter. Gives a practically straight-side, flat-topped selectivity curve! Plug-in provision for two mechanical filters. 3 kc filter standard equipment. 800-cycle plug-in unit available as optional accessory for greater selectivity on CW. Double conversion superhet covers 160 thru 10 meter bands. Accurately calibrated directly to 1 kc.... Here's a natural for the SSB operator!
In Stock! $530.00

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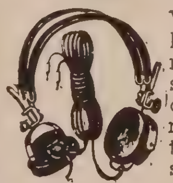

World famous Trimm headsets are highly recommended where sensitivity, quality and comfort are a necessity. Designed to give a lifetime of satisfactory service.

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PROFESSIONAL (4000 ohms)	3.41
FEATHERWEIGHT (24,000 Ohms—most popular high impedance!)	6.47

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Popular hand keys for novice or old-timer, and at prices anyone can afford to pay!

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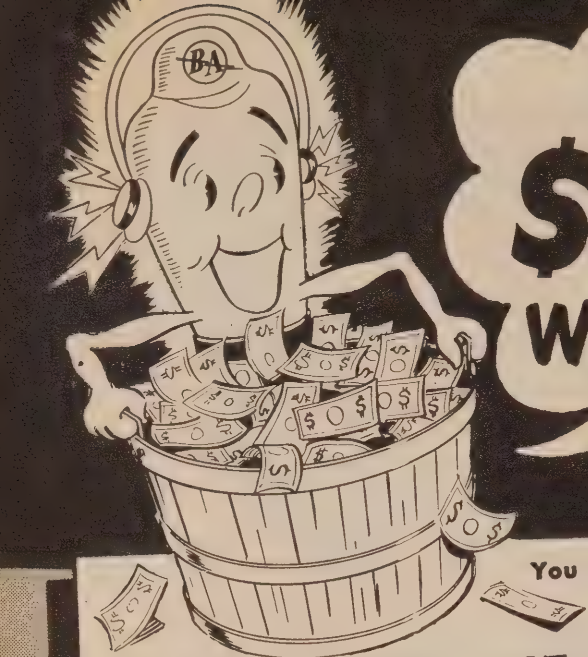

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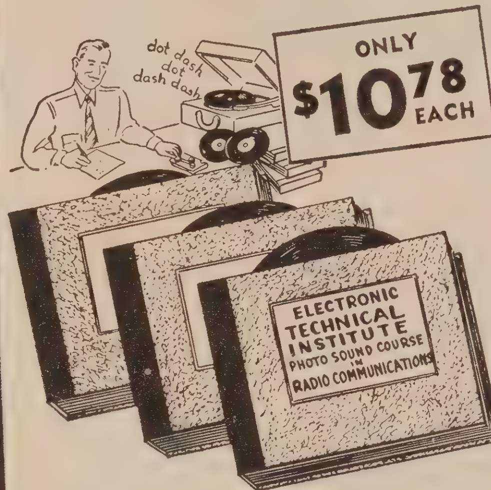
WITH THIS NEW HOME STUDY COURSE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Complete set of unbreakable code records to help in passing FCC code exams. 3 albums with 72 sides in all—includes all codes, instruction materials—everything needed to become a proficient radio telegraph operator. Letters and punctuations are as used by the FCC. Teaches only by sound — no memorizing code tables necessary. Includes practice records for copying through static and interference. Recorded at 78 RPM, plays on any standard record player or changer. Far superior to the usual code tape machines. An ideal code practice method for schools, clubs, etc., as well as for home study. Available as a complete set or in separate albums. Prepared by Electronic Tech. Inst. of Los Angeles.

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$2.35 Double Headset

FOR RADIO AMATEURS, SHORT WAVE LISTENING CRYSTAL SETS, ETC.

Popular small size, light weight, extra sensitive. Powered by Alnico No. V magnets to assure high fidelity response and excellent volume. Sturdily constructed of durable black plastic. Diameter of diaphragm is 1⅞". Adjustable spring steel headband. Complete with 4½ ft. cord with pin tips.

No. 14B473. 2000 Ohms. Each............ **$2.35**
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SPECIAL VALUE! CODE PRACTICE KIT

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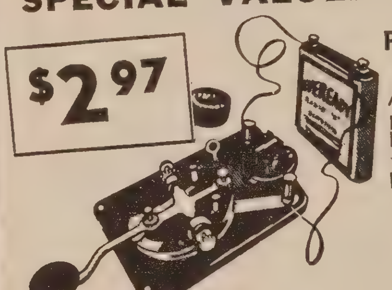

POPULAR J-38 KEY WITH HIGH FREQ. BUZZER AND BATTERIES

A Honey of a Code practice set. All parts are top quality—guaranteed to give long lasting service. Kit consists of a former $5.00 List Value Code practice key mounted on a black bakelite base with binding posts; adjustable high frequency buzzer; Wire; 4½ volt battery; and instructions for quick and simple assembly.
No. 14C671.
Complete Kit............ **$2.97**

TWO-WAY SENDING & RECEIVING SET

As above but consists of 2 keys, 2 buzzers, battery and 50 ft. of weatherproof wire to enable sending between houses, or different rooms. Includes diagram.
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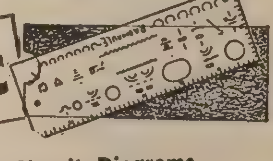
75c



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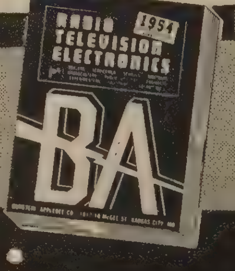

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Simplified, easy-to-learn AMECO methods have enabled thousands to PASS COMMERCIAL AND AMATEUR CODE EXAMS and AMATEUR THEORY EXAMS for their FCC license. Many have been helped to enjoy a career in communications.

AMECO courses are the result of years of thorough preparation by leading experts. Thanks to their "know-how" you can now learn Code and Theory as you never thought possible. Challenge our courses with any other . . . *you'll pay less for the best!*

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"Received your code course a week ago and can copy 10 W.P.M. already with ease. Since becoming handicapped I have found a tremendous satisfaction with your method of studying code. It's the best, bar none!"

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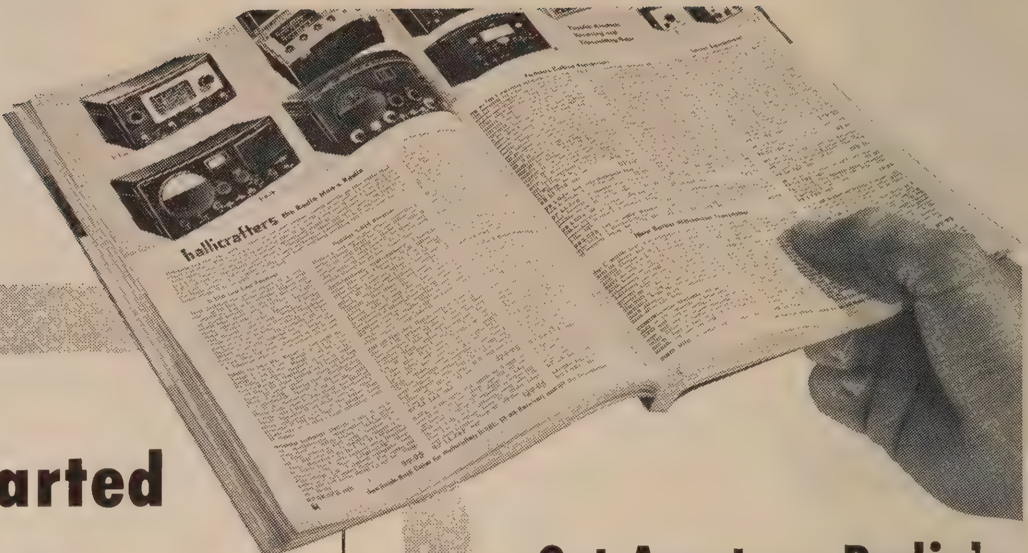

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1954 Examination Schedule

(January–June)

The Federal Communications Commission will give amateur examinations during the first half of 1954 on the following schedule. Remember this list when you need to know when and where examinations will occur. Where exact dates or places are not shown below, information may be obtained, as the date approaches, from the Engineer-in-Charge of the district (see p. 6). *Even stated dates are tentative and should be verified from the Engineer as the date approaches.* No examinations are given on legal holidays. All examinations begin promptly at 9 A.M. except as noted.

Albuquerque, N. M.: March 26.
Amarillo, Tex.: March 23.
Anchorage, Alaska, 53 U. S. Post Office Bldg.: By appointment.
Atlanta, Georgia, 411 Federal Annex: Tuesday and Friday at 8:30 A.M.
Bakersfield, Calif.: Sometime in May.
Baltimore 2, Md., 508 Old Town Bank Bldg.: Monday through Friday. When code test required, between 8:30 A.M. and 9:30 A.M.
Bangor, Me.: May 19.
Beaumont, Tex., 329 P. O. Bldg.: Monday through Friday except Thursday only when code test required.
Billings, Mont.: Sometime in May.
Birmingham, Ala.: March 4, June 2.
Boise, Idaho: Sometime in April.
Boston, Mass., 1600 Customhouse: Wednesday through Friday, 9:00 A.M. to 2 P.M.
Buffalo, N. Y., 328 P. O. Bldg.: Thursday.
Butte, Mont.: Sometime in May.
Charleston, W. Va.: Sometime in March and June.
Chicago, Ill., 826 U. S. Courthouse: Friday.
Cincinnati, Ohio: Sometime in February and May.
Cleveland, Ohio: Sometime in March and June.
Columbus, Ohio: Sometime in January and April.
Corpus Christi, Tex.: March 11, June 10.
Dallas, Tex., 500 U. S. Terminal Annex Bldg.: Monday through Friday, except Tuesday only when code test required.
Davenport, Iowa: Sometime in January and April.
Denver, Colo., 521 New Customhouse: 1st and 2nd Thursdays, 8 A.M.
Des Moines, Iowa: Sometime in January and April.
Detroit, Michigan, 1029 Federal Bldg.: Wednesday and Friday.
El Paso, Tex.: March 30.
Ft. Wayne, Ind.: Sometime in February and May.
Fresno, Calif.: March 17, June 16.
Grand Rapids, Mich.: Sometime in January and April.
Hartford, Conn.: March 9–10.
Hilo, T. H.: April 6.
Honolulu, T. H.: Monday through Friday.
Houston, Tex., 324 U. S. Appraisers Stores Bldg.: Tuesday and Friday.
Indianapolis, Ind.: Sometime in February and May.
Jackson, Miss.: March 10, June 9.
Jacksonville, Fla.: April 17.
Juneau, Alaska, 7 Shattuck Bldg.: By appointment.
Kansas City, Mo., 3200 Federal Office Bldg.: Friday.
Klamath Falls, Ore.: Sometime in May.
Knoxville, Tenn.: March 17, June 17.
Lihue, T. H.: April 20.
Little Rock, Ark.: Jan. 13, April 14.
Los Angeles, 539 U. S. Post Office and Courthouse: Wednesday, 9 A.M. and 1 P.M.
Louisville Ky.: Sometime in May.
Manchester, N. H.: June 2.
Memphis, Tenn.: Jan. 8, April 9.
Miami, Fla., 312 Federal Bldg.: Thursday.
Milwaukee, Wisc.: Sometime in January and April.
Mobile, Ala., 419 U. S. Courthouse and Customhouse: Wednesday and by appointment.
Nashville, Tenn.: Feb. 3, May 5.
New Orleans, La., 400 Aubudon Bldg.: Monday through Friday except Monday through Wednesday only at 8:30 A.M. when code test required.
New York, N. Y., 748 Federal Bldg., 641 Washington St.: Monday through Friday.
Norfolk, Va., 402 Federal Bldg.: Monday through Friday except Friday only when code test required.
Oklahoma City, Okla.: Jan. 14–15, April 15–16.
Omaha, Nebr.: Sometime in January and April.
Philadelphia, 1005 U. S. Customhouse: Monday through Friday, 8:30 A.M. to 2 P.M.
Phoenix, Ariz.: Sometime in January and April.
Pittsburgh: Sometime in February and May.
Portland, Me.: April 13.
Portland, Ore., 307 Fitzpatrick Bldg.: Friday, 8:30 A.M. for 20 and 13 w.p.m. tests; 9 A.M. for 5 w.p.m. test.
Rapid City, S. D.: Sometime in May.
Roanoke, Va.: April 3.
St. Louis, Mo.: Sometime in February and May.
St. Paul, Minn., 208 Federal Courts Bldg.: Friday.
Salt Lake City, Utah: March 19, June 18.
San Antonio, Tex.: Feb. 4, May 6.
San Diego, 15-C U. S. Customhouse: By appointment.
San Francisco, 323-A Customhouse: Monday, Novice and Technician; Friday, General and Extra.
San Juan, P. R., 323 Federal Bldg.: Thursday, and Monday through Friday at 8 A.M. if no code test required.
Savannah, Ga., 214 P. O. Bldg.: By appointment.
Schenectady, N. Y.: March 17–18, June 16–17, 9 A.M. and 1 P.M.
Seattle, 802 Federal Office Bldg.: Friday.
Sioux Falls, S. D.: March 10, June 9, Novice and Technician at 10 A.M.; others at 1 P.M.
Spokane, Wash.: Sometime in May.
Springfield, Mo.: Sometime in June.
Syracuse, N. Y.: Sometime in January and April.
Tampa, Fla., 410 P. O. Bldg.: By appointment.
Tulsa, Okla.: Jan. 18–19, April 19–20.
Tucson, Ariz.: Sometime in April.
Wailuku, T. H.: April 9.
Washington, D. C., 415 22nd St., N. W.: Monday through Friday, 8:30 A.M. to 5 P.M.
Wichita, Kans.: Sometime in March.
Williamsport, Penna.: Sometime in March and June.
Wilmington, N. C.: June 5.
Winston-Salem, N. C.: Feb. 6, May 1.

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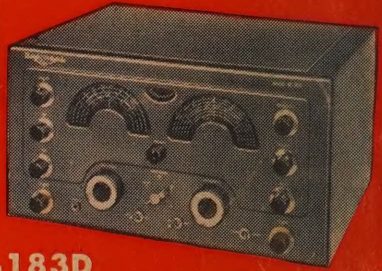
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